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THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Environmental Training Modules Module 3 - Shipyard Incident Response Training

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

in cooperation with
National Steel and Shipbuilding Company
San Diego, California

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TRAINING MODULES OVERVIEW

Executive Summary and User s Guide (NSRP 0540) Gives an overview of the 10 module set of environmental training modules, plus key issues involved in training in general. Instructions are supplied for how the modules can be modified to suit individual shipyards, as well as hardware and software requirements.

Module 1 (NSRP 0541) **Good Environmental Practices**
Content: Craft/trade-specific training on items that workers must deal with on a regular basis – material handling, labeling, waste generation/minimization, requirements awareness.
Recipients: New employees on arrival, and existing workers as a refresher.

Module 2 (NSRP 0542) **Environmental Practices for Specific Craft/Trade Groups**
Content: Specific training on air, hazardous materials, waste minimization, and related environmental considerations, with a focus on the generator personnel and their individual practices and procedures. Emphasis on those personnel likely to encounter a high incidence of problems during their regular duties.
Recipients: Specific craft/trade groups of workers.

Module 3 (NSRP 0543) **Shipyard Incident Response Training**
Content: Detailed presentation of response requirements specified by OSHA. Basic ingredients of a viable program for a shipyard – what is required and how to reach a satisfactory state of readiness. Includes specific duties of all participants, as well as how to ensure coordination and a common focus. This Module will provide the shipyards with an in-house capability for conducting this important training.
Recipients: Environmental Manager, Environmental Staff Personnel, Safety Engineer, Safety Personnel, Fire Department Personnel, Laboratory Staff and Technicians, Emergency Response Coordinator, Medical Personnel.

Module 4 (NSRP 0544) **Shipyard Oil Pollution Prevention and PIC Training**
Content: Provides a detailed overview on the federal regulatory oil pollution prevention and response requirements. Also contains specific training material for those shipyard employees with designated “Person in Charge” responsibilities.
Recipients: Ship and Craft Managers and Leadmen, Environmental and Safety Department Personnel, designated Persons in Charge.

Module 5 (NSRP 0545**) General Environmental Awareness**
Content: Overview of environmental statutes and regulations affecting shipyards, including responsibilities for compliance including both civil and criminal penalties for non-compliance. Includes an overview and explanation of environmental processes - how laws are formulated, the role of environmental groups, consultants, advisers.
Recipients: Senior Management

Module 6 (NSRP 0546) **Technical Overview of Environmental Statutes and Regulations**
Content: A general but in-depth overview of all environmental statutes and regulations with a focus on shipyard interests, and emphasis on the technical aspects of the requirements.
Recipients: Environmental Managers and staff personnel.

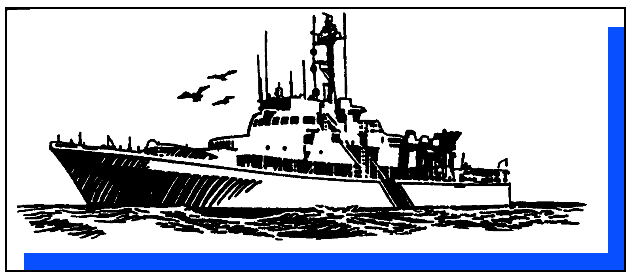
Module 7 (NSRP 0547) **Environmental Requirements of Concern to Shipyards**
Content: General overview of ALL requirements as they apply to shipyards. Emphasis on technical aspects and actions needed for compliance, rather than on the penalties for non-compliance. Includes overall strategy for developing a strong environmental posture.
Recipients: Senior Management, Supervisors, Generator Personnel; all workers who interface with environmental matters.

Module 8 (NSRP 0548) **Generation/Treatment/Minimization of Hazardous Waste**
Content: Discussion of regulatory requirements and statutes that apply to shipyard hazardous waste activities. Stresses the high points of the laws, and how to satisfy them. Includes overview of training provided to hazardous waste operators.
Recipients: Middle-level Managers

Module 9 (NSRP 0549) **Hazardous Waste Operator Training**
Content: Detailed training on practices and procedures performed by hazardous waste operators. Includes reclamation techniques, safe handling practices, labeling/marking, inventory control, hazard minimization.
Recipients: Hazardous Waste Operators; helpers and assistants

Module 10 (NSRP 0550) **Environmental Training for Subcontractor Personnel**
Content: Briefing on environmental requirements and considerations applicable to all Subcontractor Personnel entering a shipyard environment.
Recipients: Subcontractor Personnel; visitors to a shipyard; transient personnel such as delivery agents, auditors, and oversight personnel.

Shipyard Emergency Response Awareness Level Training



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National Shipbuilding Research Program
SP-1 Panel

Shipyard Emergency Response Awareness Level Training Sessions

Session 1. **Awareness Training Introduction To Regulatory Requirements Training Goals And Learning Objectives**

Session 2. **The Role Of The Shipyard First Responder Awareness Level In The Facility Emergency Response Plan**

Session 3. **Hazardous Substances and Associated Control and Out-Of Control Scenarios**,

Session 4. **The Risks and Hazards Associated With Hazardous Substances And Emergency Response**

Session 5. **The Potential Outcomes Associated With An Emergency Involving Hazardous Substances**

Session 6. **Recognizing Hazardous Substances In An Emergency Situation**,

Session 7. **Determining the Need For Additional Resources**

Session 8. **Making Appropriate Emergency Response Notifications**

Shipyard Emergency Response Awareness Level Training Outline & Objectives

Session 1. Awareness Training Introduction To Regulatory Requirements Training Goals And Learning Objectives

Session Objectives - The objectives of Session 1 are to introduce general shipyard workers, who will be trained as First Responders Awareness Level, to the OSHA Emergency Response Regulations, their requirements for training and determining emergency response roles and responsibilities. Session 1 also includes an outline of the training goals and learning objectives of this Awareness Level Training Program.

Session 2. The Role Of The Shipyard First Responder Awareness Level In The Facility Emergency Response Plan

Session Objectives - The objectives of Session 2 are to explain the roles and responsibilities of the Awareness Level Responder in the shipyard emergency response plan. Session 2 also includes explanations about several methods to help recognize hazardous problems, evaluate the potential hazard severity, and understand the responsibility to initiate the shipyard incident communication system.

Session 3. Hazardous Substances and Associated Control and Out-Of Control Scenarios

Session Objectives - The objectives of Session 3 are to provide the Awareness Level Responder with an understanding of the hazard properties of chemical substances typically used in the shipyard. Also, Session 3 includes scenarios that enlighten the Awareness Level Responders about circumstances that describe when a hazardous substance is "in-control" or "out-of-control".

Session 4. The Risks and Hazards Associated With Hazardous Substances And Emergency Response

Session Objectives - The objectives of Session 4 are to illustrate and explain the dangers associated with hazardous substances and the concepts of toxicology, dosage, exposure, and exposure routes.

Session 5. The Potential Outcomes Associated With An Emergency Involving Hazardous Substances

Session Objectives - The objectives of Session 5 are to describe potential adverse health effects and physical injuries involved with exposure to a hazardous substances in an emergency situation, including hazardous substance fires and/or explosions.

Session 6. Recognizing Hazardous Substances In An Emergency Situation,

Session Objectives - The objectives of Session 6 are to provide instruction on how to recognize and identify hazardous substances in an emergency situation. This is accomplished by describing the variety of hazardous substance forms and associated containers, identification labels on containers, and notification placards and signs on hazardous storage buildings and other potential hazardous production areas.

Session 7. Determining the Need For Additional Resources

Session Objectives - The objectives of Session 7 are to explain to the Awareness Level Responder the three levels of response required for a potential or accidental hazardous substance incident.

Session 8. Making Appropriate Emergency Response Notifications

Session Objectives - The objectives of Session 8 are to describe the specific role of the Shipyard Awareness Level Emergency Responder with respect to the shipyard emergency incident notification system. Also, Session 8 also includes a summary of the learning objectives, which concludes the Awareness Level Training materials.

Session 1
Awareness Training Introduction To Regulatory Requirements
Training Goals And Learning Objectives

Session Objectives

The objectives of Session 1 are to introduce general shipyard workers, who will receive First Responders Awareness Level Training, to the OSHA Emergency Response Regulations, their requirements for training and determining emergency response roles and responsibilities. Session 1 also includes an outline of the training goals and learning objectives of this Awareness Level Training Program.

Introduction to Regulatory Requirements

The Occupational Safety and Health Act of 1970 authorizes the Occupational Safety and Health Administration (OSHA) to develop regulations designed to protect employees who work at hazardous waste sites or industrial facilities that may be involved with hazardous substance emergency response activities. OSHA requires all workers, supervisors, and managers who work with or near hazardous materials and wastes to be trained on procedures to protect themselves and respond to hazardous emergency situations. OSHA has developed a standard entitled “Hazardous Waste Operations and Emergency Response" (HAZWOPER) to protect employees in hazardous environments and to help them handle hazardous substances and emergencies safely and effectively.

OSHA HAZWOPER regulations are codified in 29 CFR 1910.120. The regulations encompass voluntary and required clean-up operations at uncontrolled hazardous waste sites; corrective actions involving cleanup operations; operations involving hazardous wastes conducted at TSDF’s; as well as workers responding to emergencies involving hazardous materials and waste incidents. The specific section that applies to most shipyards is 1910.120 (q), which governs the Emergency Response component of the training. Shipyards generally fall under this requirement because certain shipyard employees engage in emergency response and spill clean-up activities. Also, due to the high potential for emergency response actions involving hazardous substances, fires, chemical exposures and environmental contamination, section 1910.120 (q) can apply to shipyard industrial settings.

The regulations require that all training is based on the duties of each responder identified in the facility emergency response plan. The skill and knowledge levels required for all new responders, those hired after the effective date of this standard, shall be conveyed to them through training before they are permitted to take part in actual emergency operations. Employees who are expected to participate in emergency response, shall be given training in accordance with the following table and descriptive sections:

Level of Response Training	General Duties
1) First Responder Awareness Level or Awareness Level Responder	First responders at the awareness level are individuals who are likely to witness or discover a hazardous substance release and who have been trained to initiate an emergency response sequence by notifying the proper authorities of the release. They would take no further action beyond notifying the authorities of the release.
2) First Responder	First responders at the operations level are individuals who respond to

Operations Level	releases or potential releases of hazardous substances as part of the initial response to the site for the purpose of protecting nearby persons, property, or the environment from the effects of the release. They are trained to respond in a defensive fashion without actually trying to stop the release. Their function is to contain the release from a safe distance, keep it from spreading, and prevent exposure.
3) Hazardous Materials Technicians	Hazardous materials technicians are individuals who respond to releases or potential releases for the purpose of stopping the release. They assume a more aggressive role than a first responder at the operations level in that they will approach the point of release in order to plug, patch or otherwise stop the release of a hazardous substance.
4) Hazardous Materials Specialist	Hazardous materials specialists are individuals who respond with, and provide support to, hazardous materials technicians. Their duties parallel those of the hazardous materials technician, however those duties require a more directed or specific knowledge of the various substances they may be called upon to contain. The hazardous materials specialist would also act as the site liaison with federal, state, local and other government authorities regarding site activities.
5) On Scene Incident Commander	Incident commanders will assume control of the incident scene beyond the first responder awareness level.

First Responder Awareness Training Objectives

Awareness Level Responders are workers in the shipyard who are likely to witness or discover a hazardous substance release and who have been trained to initiate an emergency response sequence by notifying the proper authorities of the release or threatened release. The Awareness Level worker will take no further action to clean-up or respond to a hazardous incident beyond notifying the authorities. The Awareness Level Responder shall have sufficient training or sufficient experience to objectively demonstrate competence of the information presented in this training module. At the end of this training Module, the shipyard workers should have a clear understanding of the following items:

1) Understand what hazardous substances are and the risks associated with them in an emergency incident.

2) Understand potential outcomes and the increased level of danger associated with an emergency when hazardous substances are present.

3) Recognize the presence of hazardous substances and take initial steps to identify the hazardous substances potentially involved in an emergency situation.

4) Understand the role of the First Responder Awareness Individual in the employer's emergency response plan. This includes site security and control, and understanding the U.S. Department of Transportation's Emergency Response Guidebook.

5) Realize the need for additional resources and make appropriate notifications to the internal or external incident communication system center.

Session 2.
The Role Of The Shipyard First Responder Awareness Level In The Facility Emergency Response Plan

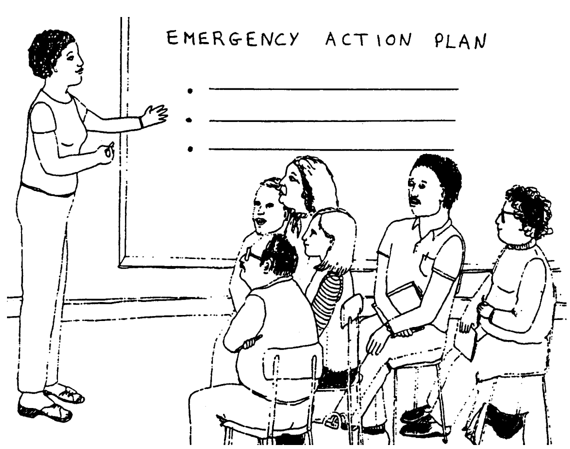
Session Objectives
The objectives of Session 2 are to explain the roles and responsibilities of the Awareness Level Responder in the shipyard emergency response plan. Session 2 also includes explanations about several methods to help recognize hazardous substance problems, evaluate the potential hazard severity, and understand the responsibility to initiate the shipyard incident communication system.

The Shipyard Emergency Response or Contingency Plan

Keeping with the shipyard's commitment to employee health and safety and environmental protection, a comprehensive program aimed at prevention of injuries, fire and environmental incidents has been implemented throughout the shipyard. If, in spite of all precautionary measures, such an event should occur, the shipyard is prepared with an on-site emergency response organization. If the situation is extremely severe, the on-site emergency procedures dictate the assistance from off-site response companies or agencies. In all incidents, large or small, the emergency response team will have protection of human health and safety as its primary objective.

Emergency Response Plans are developed and implemented by shipyards for environmental compliance and protection of employees and the environment. The emergency response plan is generally a written portion of the safety and health program. Similarly, a Contingency Plan is a RCRA required document that sets out how hazardous waste generators (i.e. shipyards) will respond to emergency situations. The Contingency Plan is very similar to an emergency response plan in that it establishes procedures to minimize potential hazards imposed by explosions, fires, and releases of hazardous substances to the air, soil, or water. Shipyards generally have emergency response plans that are required by, or prepared in conjunction with, Superfund Amendment and Reauthorization Act (SARA Title III Section 302) and Emergency Planning and Community Right-To-Know Act (EPCRA). Employers who will evacuate their employees from the work-site location when an emergency occurs, and who will not permit any of their employees to assist in handling the emergency, are exempt from some response plan development requirements.

Due to the shipyards proximity to surface waters, air, and land, a delayed or improper response to an incident involving hazardous substances, such as spills, leaks, fire and/or explosions, can cause a severe effect on the environment. To prepare for such incidents, shipyards develop and implement emergency response plans. The emergency response plan usually includes the following information:



- Notification system for hazardous substance emergency incidents.
- Procedures to follow when an emergency occurs.
- Evacuation routes and gathering areas in the shipyard.

- On-site emergency equipment and response personnel.
- Pre-emergency planning and coordination with outside responsibilities.
- Personnel roles, lines of authority, and communication.
- Emergency recognition and prevention.
- Safe distances and places of refuge.
- Site security and control.
- Decontamination procedures.
- Emergency medical treatment and first aid.
- Emergency alerting and response procedures.
- Critique of response and follow-up.
- Personal Protective Equipment (PPE) and emergency response equipment.

General Role of the First Responder at the Awareness Level

Awareness Level First Responders are a very important part of a shipyard emergency and environmental incident response plans. Awareness Level Responders are general workers in the shipyard who are likely to witness or discover:

- Hazardous substance emergencies or potential emergencies.
- Hazardous substance releases to the environment.
- Personal chemical contaminations.
- Potential releases to the environment (such as a open can of hazardous substance on a pier).
- Small spills or container with immediate spill danger left unattended.
- Fires or burning operations near hazardous substances.

The main role of the Awareness Level Responder in the shipyard is to serve as an educated observer and a pair or eyes able to recognize hazardous conditions and take initial steps to start the emergency response system. The Awareness Level Responder will take no further action beyond the initial problem identification and notification. They will not clean-up or respond to a hazardous incident beyond notifying the proper authorities. The Awareness Level Responder should make themselves available to answer questions with respect to the incident.

Recognizing When a Hazardous Problem or Emergency Exists

The Awareness Level Responder must understand the properties hazardous substance human and environmental exposure risks and their relation to potential emergency incidents. A hazardous substance emergency exists when a hazardous substance is involved with one or more of the following:

- Potential for pollution of the environment.
- Confined space entry and working conditions.
- Fire, welding and other source of ignition.
- Personal hazardous substance contaminations to fellow employees.

The First Responder is trained to understand the potential outcomes and the increased level of danger associated with an emergency when hazardous substances are present. This subject matter will be discussed in greater detail in the sessions to follow.

Understanding The Responsibility to Act

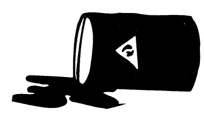
It is the responsibility of the First Responder Awareness Level to initiate an emergency response sequence by notifying the proper authorities of the release or threatened release of hazardous substances. Awareness Responders must realize the need for additional resources and make appropriate notifications to the internal or external incident communication system center.

HAZARD IDENTIFICATION	ACTION
When You See A Hazardous Substance That Poses An Immediate Threat to Health or the Environment	The First Responder Awareness Level Has A "Responsibility to Act" (i.e. Make the Required Notification)

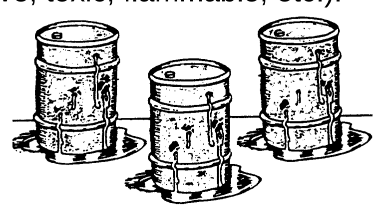
Evaluate Severity of Incident

It is important that the Awareness Level Responder have an understanding of the severity of an incident or potential incident. This understanding will help determine the appropriate level of response when the environmental incident is reported. The levels of severity for Awareness Level Response consideration can include the following:

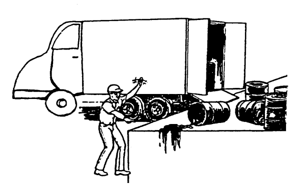
A) Low Severity:
This type of incident usually refers to a situation with one or more of the following conditions:
- Small amount (< 1 gallon) of low hazard substances.
- Small potential for human or environmental contamination.
- No potential for fire or explosion.



B) Medium Severity:
This type of incident usually refers to a situation with one or more of the following conditions:
- Medium amount of low hazard (i.e. low flammability) substances (>1 and < 5 gallons).
- Small amount of highly hazards substances (i.e. highly corrosive, toxic, flammable, etc.).
- Minor potential for human or environmental contamination.
- No Potential for fire or explosion.



C) High Severity:
This type of incident usually refers to a situation with one or more of the following conditions:
- Any amount of extremely hazardous substance.
- Medium amount of highly hazardous substances (i.e. highly corrosive, toxic, flammable, etc.).
- Large amount of hazardous substances (> 5 gallons).
- High potential for human or environmental contamination.
- Any potential for fire or explosion.



The concept of Hazardous Incident Severity will be discussed in more detail in a later session.

Initiate the Appropriate Incident Communication System

In spite of all precautionary measures, environmental and hazardous events have the potential to occur. The shipyard is prepared with an on-site emergency response team to clean-up spills and respond to emergencies. The emergency response team is capable of resolving most common incidents. The Shipyard Emergency Response System will be initiated by a telephone report from a shipyard worker or Awareness Level Responder. When reporting a spill or other hazardous material incidents to the on-site Security, Fire, Safety or Environmental Department, the caller must be prepared to provide as much information as possible including:

Report the Following Information:

1) Caller's name and badge number.
2) The location and extension from which you are calling.
3) Description of the incident (e.g. spill, leak, fire, injuries, etc.).
4) Location of incident (Building Number, Deck, Frame Compartment, etc.).
5) Other relevant information.

The Shipyard First Responder Awareness Level should stay on the line until advised that notification is complete.

Session 3.
Hazardous Substances and Associated Control and Out-Of-Control Scenarios

Session Objectives

The objectives of Session 3 are to provide the Awareness Level Responder with an understanding of the hazard properties of chemical substances typically used in the shipyard. Also, Session 3 includes scenarios that instruct the Awareness Level Responders about circumstances that describe when a hazardous substance is "in-control" or "out-of-control".

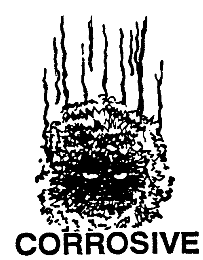
Hazardous Substances

Understanding and identifying hazards associated with handling hazardous materials in the shipyard is important for environmental health and safety and emergency response. Chemicals are an essential part of our lives, at home and at work. To ensure safety, the proper response to spills and other hazardous substance incidents must be considered. Generally, a hazardous substance is any chemical that has the potential for producing harm to human health or the environment. Mishandling or misusing hazardous substances can cause injuries and environmental damage. Proper identification of hazardous materials will help prevent personal injuries or damage to the environment.

Shipyards use several types of hazardous materials for production processes, which often results in the generation of hazardous waste. The substances and associated wastes are considered hazardous because of their chemical, physical or toxic properties. These materials are an integral part of shipyard operations and are needed to conduct shipbuilding and repair operations. A few examples of these materials are paints, solvents, waste oil, spent blasting media and plating solutions. Due to the concern for employee health and the environment and the potential for environmental emergencies, the Awareness Level Responder must understand the hazardous properties of shipyard chemicals.

Hazardous Properties

Chemicals can be categorized according to the specific hazards they present. For instance, some chemicals, such as sulfuric acid or caustic soda, cause a burn if they come in contact with human skin. Other chemicals, such as trichloroethane or lead, can cause illness after long term exposure. Still others, such as acetone and toluene, can ignite readily and present a serious fire hazard. The four basic hazard properties of chemicals are listed below:

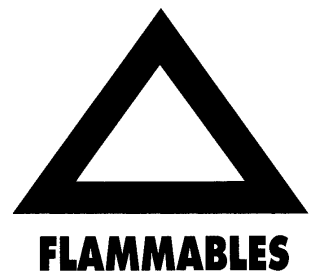


Corrosives - Corrosive chemicals can cause the destruction of living tissue, like skin and eyes, during exposure. Similarly, they can cause the destruction of non-living materials such as wood and steel. Corrosives fall into three categories: *acids; bases; and solvents*. Acids cause burns because they react with the proteins, carbohydrates, and fats that compose living tissue. Bases, or caustic solutions, degrade the proteins and fat in the skin leading to desensitization and damaged tissue. Solvents can redden and roughen skin to the point of causing dermatitis.

Toxics - Toxic substances can damage your overall health, either immediately or after some period of time ranging from months to years. Exposures vary depending upon toxicity. Acute toxicity creates an effect that is immediately noticeable or apparent within minutes/hours after the exposure. Chronic toxicity occurs when the response to the exposure is delayed, and may not be noticeable until months or years after the initial exposure. All materials can be toxic and it is the dose and frequency of exposure that determines the response.

Reactives - Reactive materials can react violently or dangerously with other common materials such as air, water, or themselves (self-polymerizing). Water reactive materials will generate extreme heat and may explode when introduced to water. Air reactive materials will burn vigorously in air, and may also explode. Self-polymerizing materials can burn vigorously in air, and may also explode.

Flammables - Flammables are materials that pose a hazard because they readily ignite and burn. These chemicals fall into a series of classes depending on their physical characteristics. A *Class I* flammable liquid is any liquid that has a flash-point below 100^{o} F. A *Class II* flammable liquid has a flash-point greater than 100^{o}F. A *combustible* liquid has a flash-point above 140^{o}F. Essentially, flammable chemicals usually can be ignited at normal room temperatures, while combustible chemicals must be heated to their flash-point temperatures before they ignite.



Sources of Information for Hazard Class Identification

The first source of information on the chemical hazards of a product is the label. The label will identify the product, physical and health hazards, and safe use instructions. Always follow the manufacturer's instructions for storage and use. The second source of information is the Material Safety Data Sheets ("MSDS") for a product will provide more detailed information on product hazards and procedures for safe usage. Review the MSDS prior to using any product for the first time, or if you are unsure about the hazards or proper safety precautions.

Hazardous Substances In-Control Vs. Out-of-Control

All chemicals can be used safely if you understand the hazards and follow the rules of hazardous chemical safety. The shipyard has initiated procedures and practices to control hazard material usage, storage, transportation and disposal. These procedures are in compliance with safety and environmental regulations. When hazardous substances are use or managed properly, the material is usually "In-Control". In contrast, when a material is improperly managed, the substance is "Out-of-Control." The following table illustrates this concept:

Condition	In-Control Example	Out-of-Control Example
Storage	Contained area with warning signs. Materials stored by computability.	Uncontained area with a high potential for exposure to humans or the environment No visible signs.
Transportation	Secured load in original containers.	Loose loads, lids, potential spillage.
Container Labeling	Original condition.	Missing labels with no replacement
Contain Type and Condition	Original container with no damage Other approved compatible container.	Damaged container with potential or real spillage and leaking substances. Improper or incompatible container.
Usage	Proper PPE and contained area, lids on containers.	Improper or limited PPE. Materials frequently left unattended.

The Awareness Level Responder must understand the basic hazards associated with hazardous substances and realized that those hazards can be kept under control with proper management. When a hazardous substance becomes out-of-control, actions must be taken to manage the potential problems.

Frequent inspections will help ensure that hazardous material are "In-Control". Correction of a situation that is "Out-of-Control" should be taken before a hazardous incident occurs. Pollution and accident prevention are the keys.

Session 4.
The Risks and Hazards Associated With Hazardous Substances And Emergency Response

Session Objectives
The objectives of Session 4 are to illustrate and explain the dangers associated with hazardous substances and the concepts of toxicology, dosage, exposure, and exposure routes.

Toxicity, Toxicology and Exposure

"All substances are poisons; there is none which is not a poison. The right dose differentiates a poison and a remedy." (Paracelsus 1493-1541) This basic tenet of toxicology can be simplified as "the dose makes the poison". Since the dose is the amount of a substance to which a person or other living organism is exposed, we can restate the above to say that "the exposure makes the poison". Hazardous substance exposure can be a serious outcome of an emergency situation. The Awareness Level Responder must be able to identify workers in the near area can be, or have been, exposed to chemicals.

If there is time, which many incidents do not afford, the specific material safety data sheet (MSDS) is the best source of information to identify the toxicity and exposure characteristics of a hazardous substance. The MSDS provides information about the potential health effects, exposure routes, and dangerous dosages. The following sections identify the definitions and common types of toxicity and toxicological health effects associated with hazardous substances.

Toxicology Definitions	
Toxicology	The study of the harmful effects of chemicals on living things.
Toxic Effects	Undesirable changes in the body because of an exposure to a chemical or other material. The kind of response (or how severe the response is) depends on the dose received.
Dose	The amount of the chemical you receive over a certain period of time. **Dose = Chemical Concentration x Length of Time of Exposure**

The following sections provide the definitions of common types of toxicity and toxicological health effects associated with hazardous substances.

Acute Toxicity: Acute toxic effects occur immediately, or in a short interval (minutes to hours), after exposure. They are typically sudden and may be severe (illness, irritation, collapse, and/or death) and are characterized by rapid absorption of the toxic material. Acute exposures are the most common and easiest to recognize in an emergency situation. They usually occur due to an over exposure to a hazardous substance contacted either through inhalation, skin contact, or through the ingestion. Inhalation and skin contact related exposures are the most common in emergency response situations.

Chronic Toxicity: Chronic exposure means a relatively low level of exposure that occurs over a relatively long period of time. Chronic toxic effects result from chronic exposures. A chronic effect is one that develops slowly over a period of time or that recur frequently. Chemicals will be considered

to cause chronic toxicity if they cause serious irreversible effects other than cancer or damage to reproductive cells.

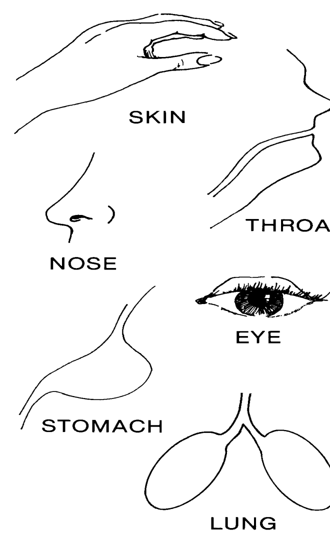
Carcinogenicity: Carcinogens are chemicals that are known to cause cancer in humans or animals. The cancer may not appear until many years after the exposure.

Reproductive Toxicity/Teratogenicity: Chemicals are classified as teratogens and reproductive toxins if they affect the ability to conceive, bear or nurture offspring and anything that influences the function or viability of sperm cells.

Exposure Routes

The concept of exposure routes is very important for the Awareness Level Responders because of their need to recognize a hazardous situation. The term exposure is important as well as the understanding of the relationship between exposure and the route. Exposure is dependent upon the degree that a substance comes into contact with surfaces of the organism capable of absorbing it. Exposure is similar to the concept of dosage. There are basically three surfaces associated with environmental human exposure and they are related to the three exposure routes.

Exposure Route	Absorption Site
1. Inhalation	**lungs** by inhalation (breathing in) and absorption through the lung walls into the body
2. Dermal	**skin** by direct contact and absorption through the skin into the body (also eyes)
3. Oral	**digestive tract** by ingesting (swallowing) substances into the body digestive tract or gastrointestinal (G.I.) tract



The route of exposure can result in different rates of absorption and different toxic effects.

1. - Inhalation Exposure (the Lung Exposure Route):

Inhalation exposure is the most common way that hazardous substances enter the body, especially in an emergency response situation. The lungs are the largest exposed surface area of the body and facilitate the transfer of gases into and out of the body. If your alveoli (the tiny sacs at the bottom of the lungs) were flattened out, they would cover an area the size of a tennis court. This huge surface area is only one single cell thick, which allows a chemical to travel into the bloodstream quickly. The large surface area results in rapid absorption and rapid excretion if the gas is not bound to tissue. Some materials have good “warning properties”, such as odor, which enables individuals to know when they are being exposed.

Inhaled particulate compounds may be deposited in different areas of the lungs depending on the particle size, with the smallest particles penetrating the furthest. Once deposited, particulates in the lunges can either have an acute or chronic toxic effect.

2. - Dermal Exposure (The Skin Exposure Route):

The skin is a specialized organ that provides a barrier between the environment and internal organs. The skin is not highly permeable and provides good protection against most compounds. Although, a small amount of toxicants can enter through the hair follicles and sweat glands, the majority of chemicals must pass through the densely packed skin cells before entering into the blood stream.

Contact with a chemical substance by the skin is called dermal contact and may cause two major effects: 1) Local Effects and 2) Systemic Effects

1) Local Effects:	
Irritation	Many chemicals cause an immediate reddening, rash, or other irritation to the skin upon contact.
Tissue damage	Chemicals such as corrosives, including acids or bases, eat into the skin and cause damage to the tissue beneath it.
Allergic effects	Some chemicals, such as nickel, chromium, formaldehyde, turpentine, and isocyanates, cause the skin to become hypersensitive after repeated exposures. This is called sensitization dermatitis.
2) Systemic (internal) Effects:	Systemic effects from absorption through the skin. Many solvents are absorbed through the skin, circulated through the bloodstream, and then cause damage within the body.

3. - Oral Exposure (The Digestive Tract Exposure Route):

The gastrointestinal (G.I.) tract can be thought of as a tube going through the body. Chemicals that are eaten, intentionally or accidentally, may be absorbed into the body through this “tube” where toxic effects can occur.

Dose/Response Relationship

The dose/response relationship is the basis for measurement of toxicity and the study of toxicology. For the dose/response relationship to be valid, increasing the dose should result in an increased toxic response. All studies of toxicology are based on the dose/response relationship. This is an attempt to relate the amount of a substance (the dose), given to a test subject (human or animal), to the effects experienced by subject (the response).

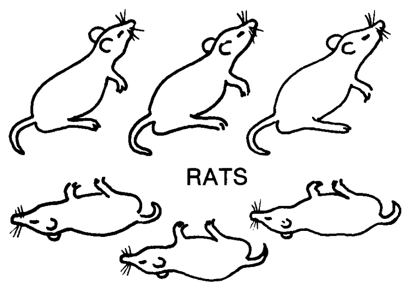
Example of the Dose/Response Concept:

Dose = Concentration	Time	Response
1 quart of 12% ethanol (alcoholic beverage)	15 mins.	brain effects ("drunk")
1 quart of 12% ethanol	daily	chronic organ damage
1 quart of 12% ethanol	annually	no observed effect

The same dose given over a short period of time may have a substantial effect, while the same dose over a long period of time may have no effect at all.

Lethal Dosage LD-50 (Lethal dose - 50%)

The simplest toxicology study relates the percentage of test animals that die (mortality) from the dose given. The dose is usually expressed in mg/kg for ingestion or inoculation, in mg/M^2 for skin exposure, or in mg/M^3 for inhalation. The response is expressed in percent (%) of animals that have died at a given dose. The dose of a chemical that kills 50% of the test animals is the LD-50. The chemical may be given by mouth (oral), applied to the skin (dermal), or injected (parenteral). A given chemical will generally show different LD-50 values depending on the route of administration and the species of the test animal. The LD-50 measures acute toxicity and is a commonly used measure of relative toxicity. The important thing for hazard awareness is that a low LD-50 value means that the chemical is more toxic, (i.e. 1 mg/M^3) while a high LD-50 (i.e. 10,000 mg/M^3) indicates a less toxic chemical.



LD_{50} (ORAL RAT)
NaCN 6 mg/kg

An example of the dose/response relationship can be illustrated by dumping shots of I00-proof whiskey into a ten-gallon tank containing ten goldfish. How many shots (dosage) will cause the fish to swim upside down. After one or two shots, none of the fish die, but after about four shots, one of the fish dies. As more shots of whiskey are added, more fish, begin to die. After ten shots, five of the ten or 50% of the goldfish are swimming upside down. If the effect being observed is death, then the lethal dosage (LD50) would be the measure of the lethal dose for 50% of the population.

Session 5.
The Potential Outcomes Associated With
An Emergency Involving Hazardous Substances

Session Objectives
The objectives of Session 5 are to describe potential adverse health effects and physical injuries involved with exposure to a hazardous substance in an emergency situation, including hazardous substance fires and/or explosions.

Types of Toxic Substance and Their Health Effects

There are five types of toxic effects that hazardous substances may have on the body. These are important to understand in an emergency situation. A single hazardous substance may cause more than one type of effect at the same time.

1. Asphixiants
A *simple asphyxiant* displaces the oxygen in the environment necessary to maintain life. These asphixiants are very important in confined spaces and especially in emergency situations. Examples are: carbon dioxide, ethane, helium, hydrogen, methane, and nitrogen. Another type of asphixiant is a *chemical asphyxiant,* which prevents the uptake of oxygen by the cells of the body. Examples are: carbon monoxide, hydrogen cyanide, and hydrogen sulfide. At high levels, all asphyxiates can cause collapse, unconsciousness, and death.

2. Irritants
An irritant is a material that causes inflammation to a part of the body by direct contact. The two types are respiratory irritants and skin irritants.

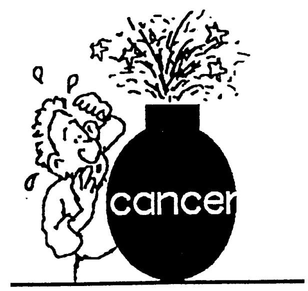
Respiratory Irritants	Causes injury to the nose, mouth, throat and lungs. Materials that are very water soluble affect mainly the nose and throat (i.e., ammonia, formaldehyde). Less water soluble materials act deeper in the lungs (i.e., nitrogen dioxide, phosgene).Examples of chemicals that affect both the upper and lower lung are chlorine and ozone. Respiratory tract irritation can be minor, such as a tightening of the chest or bronchitis, but it may also be very serious, as in the case of pulmonary edema, which can cause death.
Skin Irritants	May cause contact dermatitis, a redness, itching and drying of the skin. Examples are organic solvents and detergents. Very corrosive agents, such as chromium and nickel, can cause skin ulcers and destroy tissue.

3. Allergenic Sensitizers
After repeated exposures to certain chemicals, some individuals experience an allergic or immune reaction. Allergic sensitizers generally affect the skin and respiratory tract. The symptoms are often the same as those caused by irritants. Examples of such symptoms include dermatitis or bronchitis. As with irritants, the response may be very serious, and may even cause death. Examples include: isocyanates, phenol resins, and epoxy resins.

4. Systemic Toxins (5 Internal Poisons)

Blood System (Hemolytic) Toxins	These toxins damage blood cells or interfere with blood cell formation. Examples include benzene, methylene chloride, arsine, phosphorus, and naphthalene.
Nervous System (Neuro) Toxins	These toxins damage the nervous system. Typical symptoms include dullness, muscle tremor, restlessness, convulsions, loss of memory, epilepsy, and loss of muscle coordination. Examples include mercury, insecticides, hexachlorophene, and lead.
Liver (Hepato) Toxins	These toxins cause liver damage, including jaundice and liver enlargement. Examples include alcohols, carbon tetrachloride, and nitrosamines.
Kidney (Nephro) Toxins	These toxins damage the kidneys, causing swelling and increased serum proteins in the urine. Examples include halogenated hydrocarbons and heavy metals.
Reproductive Cell (Gameto) Toxins	These toxins damage the reproductive cells (egg and sperm) or interfere with their formation. Examples include lead, cadmium, cellosolves, and vinyl chloride.

5. Carcinogens, Teratogens, and Mutagens



Carcinogens: Carcinogens cause cancer. Cancer is the uncontrolled growth of malignant (harmful) cells at any site in the body. The development of cancer may be delayed for 20 to 30 years after the exposure. Examples include vinyl chloride, asbestos, ethylene dibromide, and acrylontrile.

Teratogens: Teratogens are toxins that cause physical defects in a developing embryo or fetus. In the 1960s methyl mercury was the first industrial chemical shown to be a teratogen. Other examples include thalidomide, some types of anesthetic gases, and ionizing radiation.

Mutagens: Mutagens are toxins that cause a change (mutation) in human genetic material. Mutation of the reproductive cells may cause birth defects in future children. Mutation of other cells in the body may cause cancer or defects in developing embryos or fetuses. Examples include ethylene oxide, benzene, hydrazine, and ionizing radiation.

Fire/Explosion Hazards

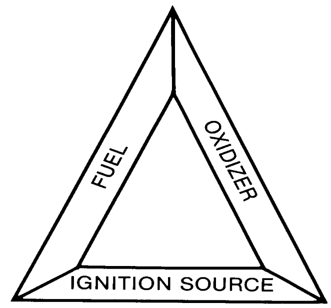
There are many hazardous materials that will ignite and burn under certain conditions. These substances are very dangerous and deserve special attention. Within the hazardous materials and waste industry, there are three main terminologies that are used to define substances that burn.

Agency	Terminology For Flammable Substances
The Department of Transportation (DOT)	Two terms used to define materials that burn, *flammable and combustible*. A flammable liquid is a material exhibiting a flash point of less than 100^{o} F. A combustible liquid is a material exhibiting a flash point of between 100 and 200 ^{o} F.
The Environmental	Defines wastes that burn *as ignitable liquids* exhibiting a flash point of less than

Protection Agency	140 ^{o} F
The National Fire Protection Association (NFPA)	Divides flammable materials with a flash point below 100^{o} F as follows: Class IA - Liquids having a flash point below 73^{o}F and a boiling point below 100^{o} F. Class IB - Liquids having a flash point below 73^{o} F and a boiling point above 100^{o}F. Class IC - Liquids having a flash point between 73^{o}F and 100^{o}F regardless of the boiling point.

The Fire Triangle

Combustion is a chemical reaction between two substances, one of which is usually oxygen accompanied by the generation of light and heat. Fire hazards can be understood by examination of the fire triangle which illustrates the three circumstances that must be present for fire to occur. Once a fire has been initiated, heat, fuel, and oxygen are necessary to sustain a burning situation. The fire cannot continue if one of these components is removed.



Explosive Situations

Gases and vapors have limited concentration ranges in which they may burn or explode. Concentrations below this specific range of air to fuel, causes the mixture to become too "lean" to burn. Similarly, concentrations above this specific range of air to fuel, causes the mixture become too "rich" to burn.

This concept is only applied when oxygen (air) is present in a finite quantity. In a situation where oxygen is present in relatively unlimited quantity, such as outdoors or a well-ventilated area, this concept is not always applicable due to the wide range of air/fuel mixtures. The flammable range for each type of hazardous substance is different and is defined by the Lower and Upper Explosive Limits (LEL and UEL).

Explosive ranges for some common compounds are given below:

Hazardous Substance	LEL	UEL
Acetone	2.6%	12.8%
Benzene	1.4%	8.0%
Gasoline	1.3%	6.0%

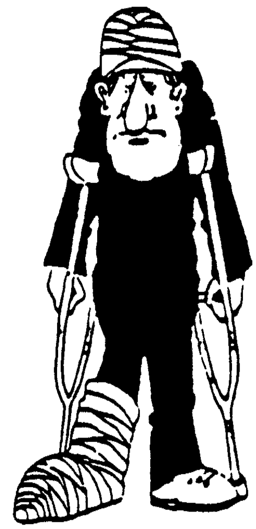
Values in % by volume in air (Sax, et al., 1987)

Flammable Solids

In addition to flammable gases and liquids, there are also flammable solids. DOT defines flammable solids as solids, other than explosives, that can be ignited by friction, moisture, spontaneous chemical change or by retained heat from process or manufacture. Examples of flammable solids are magnesium metal, nitrocellulose, sodium metals, and many hydrides.

Physical Injury During Hazardous Emergencies

Potential injuries in a hazardous substance emergency are real because workers can be exposed to a variety of hazards that may cause injury. It is very important the Awareness Level Responder understands the risks involved. For example, an employee can be exposed to hazardous substances from head to toe, which could result in extreme physical damage to the eyes, face, skin, hands, legs and feet. The exact physical injuries and possible scenarios for hazardous substance emergencies are limitless. Caution must be exercised in all emergency situations, especially those that involve toxic substances. It must be understood that when chemical substances are involved in an emergency situation, the potential for physical injuries is significantly increased.



Potential Environmental Damage

All hazardous substances can damage the environment. The environment is considered to be the "air we breath, the land we live on, and the water we drink, fish, and swim in". It is important to understand that the contamination of the environment will have an adverse affect on employees, communities and the population in general. Pollution pathway analysis with respect to local environmental surroundings is an important concept to understand when considering potential for environmental damage.

Awareness Level Response employees must be aware of possible hazardous substance environmental pollution pathways. Storm drains are located throughout the shipyard. All storm drains discharge to adjacent surface waters. It is important for the Awareness Level employee to understand the various types of hazardous substances and their potential pathways to the environment.

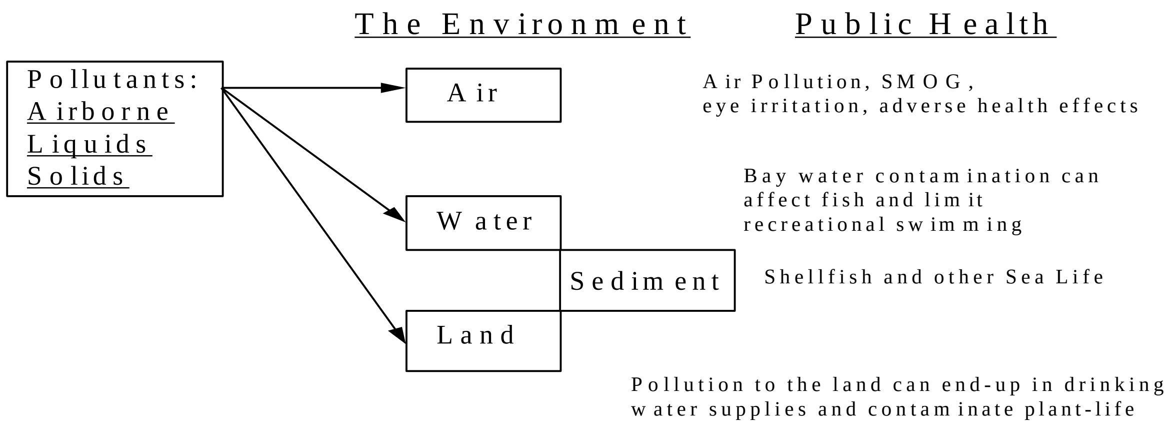
Within the shipyard there are a variety of hazardous materials that can be transported to surface waters, the ground, or to air if an accident should occur. Accidents involving chemical or hazardous substances can occur at any time or place in the shipyard. Areas that pose a significant risk are those that have direct pathways leading to adjacent surface waters and involve hazardous substances that include but are not limited to those listed in the following table:

Liquids	Solids	Airborne
Paints, Solvents, Fuels, Oils, Waste Water	Blast Materials, Grease, Salts, Cans, Containers, Liquid Containers, Solid Sludge	Paint Over-Spray, Grit Blast, Dust, Volatile Organic Compounds (VOC's), Welding Emissions, Wind Blown General Trash, Etc.

Note: Major pathways to the waters are storm drains, utility trenches, direct runoff channels, direct dumping of waste overboard, freeports, scuppers and drains on piers and ships, and unsealed manholes.

The following figure identifies a multimedia approach towards pollution pathway analysis:

Pollution Pathways



Summary

There are a number of potential adverse health effects and physical injuries involved with exposure to a hazardous substances in an emergency situation. Also, there are dangers associated with hazardous substance fires and/or explosions that are unique and expose extreme immediate danger to employees. Protection of life and personal safety is always the first priority in an emergency incident. As a second important priority, potential environmental pollution must be considered and efforts should be put in place to prevent or minimize environmental pollution.

Session 6.
Recognizing Hazardous Substances In An Emergency Situation

Session Objectives
The objectives of Session 6 are to provide instruction on how to recognize and identify hazardous substances in an emergency situation. This is accomplished by describing the variety of hazardous substance forms and associated containers, identification labels on containers, and notification placards and signs on hazardous storage buildings and other potential hazardous production areas.

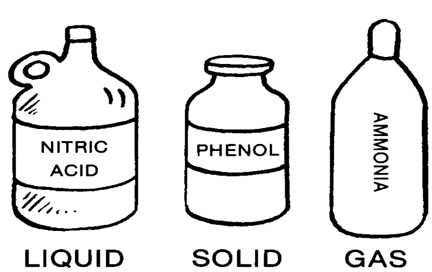
Hazardous Substance Forms and Associate Container Types

To recognize hazardous substances, Awareness Level Responders must have a good understanding of the variety of hazardous substance forms and associated containers. This will enable the Awareness Level Responder to determine if a hazardous substance is involved with the incident and provide a better understanding of the hazardous condition. A proper chemical label on the container provides valuable information about chemical exposure and spill clean-up.

A hazardous substance may take the form of a solid, liquid or gas. As a substance is cooled or heated it may change from one form to the other. The hotter the workplace environment (or the more heat used in the process), the more a liquid or solid will evaporate or otherwise give off harmful fumes and vapors, which is very important when there is a potential for fires or explosions. The following table illustrates examples of shipyard substances, their forms and various container types:

Substance Forms	Shipyard Hazardous Substance Example	Example Potable Container Types
1. Solids	Cyanide, Grit, Paint Solids, Production Dust, Fiberglass, Welding Fumes	Hazardous solid substances generally are packaged in high performance bags, boxes, and cans/jars (plastic and metal).
2. Liquids	Paints, Solvents, Acids	Hazardous liquid substances generally are packaged in metal cans 1 to 5 gallons, drums (plastic and metal) and a variety of jars made of plastic, metal or glass.
3. Vapors & Gases	Welding Gasses, Welding Fumes, Aerosols	Hazardous gases are packaged in high performance pressurized cylinders from 5 to 500 pounds in weight.

Note: All types of materials, especially hazardous gasses and liquids can be stored in large permanent tanks in the shipyard.



1. Solids

Solids which are most dangerous to your health are dusts, fibers, and fumes. These types of solids are so small that they can be inhaled directly into the lungs, where they may damage the lungs or pass into the bloodstream to harm other parts of the body.

Solid Type	
Dusts	Solid particles made by handling, crushing, or grinding materials such as rock, metal, coal, wood, or grain. Any process that creates dusts in the air should be considered hazardous until industrial hygiene testing proves it safe.
Fibers	Dust particles whose shape is long and narrow rather than rounded. If the length is three or more times the width of a particle, it is called a fiber. The most well known fiber in the industry is the *asbestos* fiber.
Fumes	Tiny solid particles produced by heating metals. Fumes are produced mainly in industrial high-heat operations, like welding, melting and furnace-work. Fumes are often mixed with hazardous gases, like ozone and nitrogen oxides, which are taken in by the lungs at the same time. Aerosol is the general term for any airborne particle, whether solid or liquid.

Note: Particle size is important in determining how harmful a particle is to your health. Particles range in size from 0.1 to 25 micrometers. Only particles of less than five micrometers stay suspended in the air long enough to be inhaled. These fine particles cannot be seen without a microscope, but they are the most dangerous to your health because they penetrate deep into the lungs.

2. Liquids

Hazardous liquids are used and generated in large quantities in shipyards and can pose a significant threat for human exposure and environmental contamination. Liquids can splash or spill onto people and into the environment. Hazardous liquid containers are used, stored and transported throughout the shipyard and pose a continuous threat of spillage and personal contamination. Liquid chemicals can enter the body through all three exposure routes.

3. Vapors & Gases

A vapor is the technical name for the gaseous form of a liquid. Vapors are generated from the surface of a liquid, just as water vapor always exists over water. The closer a liquid is to its boiling point, the more it vaporizes. Liquids with boiling points just above room temperature vaporize readily, and are called volatile.

A gas is a fluid that expands quickly to fill the space that contains the gas. In other words, gasses will expand and seek to take up more area and become less concentrated. Many gases are highly flammable and very reactive, both chemically and within the body. Gases for welding operations are contained in pressurized cylinders throughout the shipyard. These containers pose significant risk to human safety and to the environment during an emergency incident. If a compressed gas cylinder is in the immediate area to an incident, it adds an extra element of risk, in that it may result in rapid release of the gas, which can project the heavy cylinder like a torpedo.

Hazardous Container Labels

All containers of hazardous chemicals that enter the shipyard must have a label. The label is the primary source of information regarding the hazards of a chemical. The first time a person handles a chemical, and whenever a significant period has passed since the information has been reviewed, the detailed precautionary information on the label should be reexamined. This information will include:

- **What Is The Hazard**
- **How To Avoid The Hazard**
- **How To Recognize Exposure**
- **What To Do In Case of Exposure**
- **How To Handle Spills and Accidents**

In the event of a spill or personal chemical exposure, it is imperative that Awareness Level Responder knows the type and nature of the chemical involved. A proper chemical label will provide the necessary information to clean-up the spill or attend to the chemical exposure (i.e., wash eyes with water).

The Signal Word and Statement of the Hazard:
The "Signal Word" alerts the person using the chemical to the level of the hazard associated with using the material. The choice of signal word depends on the nature of the hazardous substance, its concentration, and the degree of harm exposure will cause. The Awareness Level Responder must understand the "Signal Word" because it will be the most visible on the chemical container label. When used to identify FIRE HAZARDS, the Signal Word has the following meanings:

Signal Word! Example	STATEMENT OF HAZARD	FLAMMABILITY LEVEL
DANGER! Gasoline	EXTREMELY FLAMMABLE	Flashpoint below 20^{o}F
WARNING! Toluene	FLAMMABLE	Flashpoint between 20^{o}F and 100^{o}F
CAUTION! Diesel Fuel	COMBUSTIBLE	Flashpoint between 100^{o}F and 200^{o}F

Persons identifying hazardous substances should always identify the **"Signal Word"** and **the "STATEMENT OF THE HAZARD".**

TYPICAL STATEMENTS OF HAZARD	
- MAY BE FATAL IF SWALLOWED - HARMFUL IF SWALLOWED - MAY BE FATAL IF INHALED MAY - MAY BE FATAL IF ABSORBED THROUGH SKIN - HARMFUL IF INHALED - MAY CAUSE ALLERGIC RESPIRATORY REACTION - CAUSES SEVERE BURNS - EXTREMELY FLAMMABLE	- CAUSES IRRITATION - CAUSES SKIN ALLERGIC REACTION - CONTACT WITH ACID LIBERATES POISONOUS GAS - HIGHLY VOLATILE - CONTACT WITH WATER MAY CAUSE FLASH FIRE - POWERFUL OXIDIZER - MAY FORM EXPLOSIVE PEROXIDES

Types of Container Labels

There are four main types of container labeling systems used to identify potentially hazardous substances and the specific hazards they present.

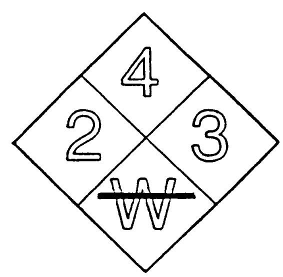
1) American National Standards Institute (ANSI)
The ANSI label mainly uses words to communicate information. It lists the physical and health hazards, including the target organ effects. The level of hazard and Signal Word is printed on the upper left side of the label. The signal words and their meaning are:

- ***DANGER*** Serious hazard
- ***WARNING*** Less hazardous but still severe
- ***CAUTION*** Moderate hazard but still of concern

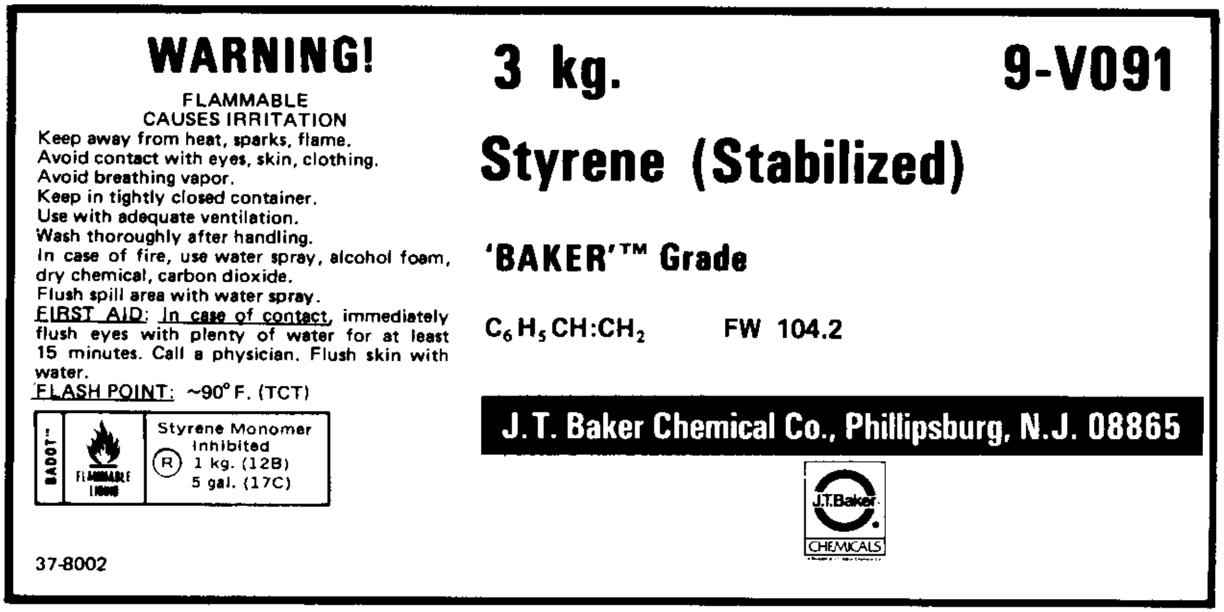
2) Department of Transportation (DOT)
DOT labels are diamond shaped and are usually present on containers and vehicles for transportation purposes. Colors and symbols that are used to represent the hazards are presented in the following table:

HAZARD	COLOR
EXPLOSIVE	ORANGE
FLAMMABLE GAS OR LIQUID	RED
FLAMMABLE SOLID	RED STRIPED
NON-FLAMMABLE GAS	GREEN
COMBUSTIBLE	RED
OXIDIZER	YELLOW
POISON OR TOXIC	WHITE
RADIOACTIVE	YELLOW & WHITE
CORROSIVE	BLACK & WHITE

3) National Fire Prevention Association (NFPA)
The NFPA labeling system is mainly intended to convey hazard information concerning chemical products to fire fighters and other emergency responders. The NFPA uses four-color coded diamonds to communicate the hazards. The numbers represent the degree of hazard. The hazards are rated on a scale of zero to four. Zero or one means no hazard or minimal hazard and a four represents a high or severe hazard.



4) Hazardous Material Information System (HMIS)
The HMIS labeling system provides the degree of hazard of a chemical under normal usage conditions. The HMIS label lists the chemical name, health hazard, flammability, reactivity, and personal protective equipment. A number, from zero to four, represents the degree or severity for the hazard similar to the NFPA labeling method.



Summery

First check the physical form, the container type and label if it is safe to do so. Use information provided by the chemical labels to prepare emergency responders for the incident at hand. Perform preliminary evaluation of potential environmental and personal contamination hazards, which includes the type of chemical hazards and exposure routes and potential pollution pathways.

Session 7.
Determining the Need For Additional Resources

Session Objectives
The objectives of Session 7 are to explain to the Awareness Level Responder the three levels of response required for a potential or accidental hazardous substance incident.

Determining the Need for Additional Resources

Hazardous substance incidents in the shipyard will vary greatly with respect to the potential or actual danger to life and the environment. For example, if a person is injured and a hazardous substance is involved, this requires a substantially different response than a situation where a container of paint has a potential of being spilled. In general, spill hazards and hazardous substance emergencies in the shipyard fall into one of three response categories. The response categories are based on the immediate need of attention, the potential for fire, the existence of injuries and the potential need of evacuation procedures. These three Levels of Hazard Substance Incidents are described in the following table:

Response Level	Example Situation
High Risk - Immediate Danger with Injuries	- All immediate employee health problems (collapse, vomiting, burning, blinding, etc.), with exposure to a hazardous substance. - All fires in the shipyard (identify if hazardous substance may be present). - All spills that are released into nearby waters. - All spills of flammable substances in a confined area or space. - All incidents involving extremely flammable substances or extremely toxic or corrosive substances. - All accidental compressed gas releases or the immediate threat of a compressed gas release.
Medium Risk - Spill With Other Potential Dangers	- All spills of hazardous substances in significant quantities (>5 gallons) - All spills of high toxicity substances. - All spills that are not causing an immediate health problem, but have a potential to expose employees. - All spills that are not causing an environmental release, but have a potential to be released to the environment.
Low Risk - Small Spill or Potential Spill or Other Hazardous Substance Condition	- All small incidental spills of 1 gallon or less of low toxicity substances (i.e. paints) with no potential to be released into local waters. - All potential conditions that pose a threat to employees or to the environment. For example, an open can of paint on the edge of a pier.

Risk determination is usually conducted by taking the following four variables into account:

1) The <u>employee exposure</u> present or potential
2) The <u>hazards or toxicity</u> level associated with the hazardous substances involved
3) The <u>volume</u> of the hazardous substances involved
4) The <u>location</u> of the spill - area access, ventilation, immediate pathway to surface water, access to clean-up materials

Emergency Response Individuals and Their Resources

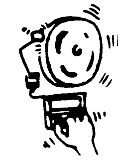
The shipyard has several levels of resources (i.e. responders) to apply to hazardous substance emergencies or incidents. It is important that the right resources are used to respond to the incident. It is always better for the Awareness Level Responder to initiate a response that may require greater resources that to notify for a lesser risk situation. In other words, it is better to err on the safe side and have too many resources than to not have enough to handle the incident.

Response Individual	Emergency Resource Functions
First Responder Awareness Level	Witness or discover a hazardous substance incident and initiate an emergency response sequence by notifying the proper authorities. They take no further action beyond notification and perform no spill clean-up activities.
First Responder Operations Level	Respond to releases or potential releases of hazardous substances as part of the initial response to the site for the purpose of protecting nearby persons, property, or the environment from the effects of the release. They are trained to respond in a defensive fashion without actually trying to stop the release. Their function is to contain the release from a safe distance, keep it from spreading, and prevent employee exposures.
Hazardous Materials Technicians Response Level	Respond to releases or potential releases for the purpose of stopping the release in order to protect employees and the environment. They assume a more aggressive role than a first responder at the operations level in that they will approach the point of release in order to plug, patch or otherwise stop the release of a hazardous substance. If they are trained fire fighters, they will perform functions to control ignition and perform life saving functions as necessary.
Hazardous Materials Specialist Level	Respond with and provide support to hazardous materials technicians. Their duties parallel those of the hazardous materials technician, however their duties require a more directed or specific knowledge of the various substances they may be called upon to contain. The hazardous materials specialist would also act as the site liaison with federal, state, local and other government authorities regarding site activities. In a shipyard setting, this individual can be a member of the Environmental Department or the Safety Department.
On Scene Incident Commander Level	Incident commanders will assume control of the incident scene beyond the First Responder Awareness Level. Once the incident is reported, the On-Scene Incident Commander will take over and organize all activities to respond to the incident at hand. The On-Scene Incident Commander will identify the exact required resources and notify off-site response companies or agencies when necessary.

Two Shipyard Examples:

A spill of a low hazard material, in a small amount, (i.e., a few gallons or less of hydraulic fluid), in a location that is not an immediate threat to people or the environment, can be cleaned up by *First Responder at the Operations Level*. On the other hand, a large volume spill of a high hazard material, (i.e., a 55 gallon drum of flammable solvent), in a location where people or the environment maybe injured, requires a quick response by individuals trained at a minimum of the *Hazardous Materials Technicians Response Level.*

The Awareness Level Responder has one major function, which is to provide quick and complete reporting of emergency incidents in the shipyard.



Awareness Level Responders will perform emergency notification for all types of emergencies including but not limited to the following:

- Injury accidents
- Fires
- Smoking of unknown origin
- Personal chemical contamination
- Environmental pollution
- Dangerous hazardous materials handling
- Confined space spills or accidents

Clear, calm and accurate emergency notification will result in a fast appropriate response. This will be detailed in the next section.

Session 8.
Making Appropriate Emergency Response Notifications

Session Objectives
The objectives of Session 8 are to describe the specific role of the Shipyard Awareness Level Emergency Responder with respect to the shipyard emergency incident notification system. Also, Session 8 also includes a summary of the learning objectives, which concludes the Awareness Level Training materials.

Incident Response Notification System

In spite of all precautionary measures, environmental and hazardous material incident events can occur. The Awareness Level Responder should be able to identify these problems and their severity. The shipyard is prepared with an on-site emergency response organization and/or resources to be able to respond to hazardous substance emergencies and spill clean-ups. The emergency response resources are capable of resolving most common situations in the shipyard. In extreme cases that warrant off-site assistance, the Incident Commander will be the individual requesting assistance from off-site response companies or agencies. The shipyard emergency response organization and resources will have protection of human health and safety as its primary objective during all shipyard hazardous substance incidents.

In most instances, the shipyard emergency response system will be initiated by a telephone report from a shipyard worker or an Awareness Level Responder. When reporting a spill or other hazardous materials incident to on-site Security, Fire, Safety or Environmental Department, the caller should be prepared to provide as much information as possible, including any information about the hazardous substances and potential environmental or human contamination.

<u>Call the on-site security or emergency response</u> (i.e. fire department) and give them the required information and need for additional resources.

Report the Following Information:

1) Caller's name and badge number.
2) The location and extension from which you are calling.
3) Description of the incident (i.e., spill, leak, fire, and injuries, etc.).
4) Description of hazardous substances involved.
4) Location of incident (Building Number, Deck, Frame Compartment, etc.).
5) The need for additional resources.
6) Other relevant information.

The Shipyard First Responder Awareness Level should stay on the line until advised that notification is complete.

Emergency Response Awareness Level Training Summary

The Awareness Level Training provided an introduction to the OSHA Emergency Response regulations and how the regulations dictate requirements for training and identifying emergency response roles and responsibilities. The roles and responsibilities of the First Responder at the Awareness Level are generally defined in the shipyard emergency response plans and in this training manual. Awareness Level training has included subjects about recognizing hazardous substance problems, evaluating potential hazard severity, and understanding the responsibility to initiate the shipyard incident communication system when such circumstances are observed.

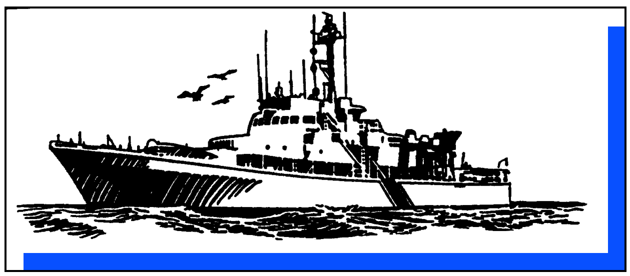
The sessions provided a basic introduction to the properties of hazardous substances, their hazardous properties and potential health effects. Dangers associated with human toxicology, the concept of dose/response, exposure, and routes of exposure in emergency situations were explained. Included were scenarios to enlighten the Awareness Level Responders about circumstances and scenarios that describe when a hazardous substance is “in-control” or “out-of-control”.

First Responders at the Awareness Level must be able to recognize and identify hazardous substances in an emergency situation in order to perform proper identification and reporting. To recognize hazardous substances, Awareness Level Responders must have a good understanding of the variety of hazardous substance physical forms and their associated containers. Identification labels on containers and notification placards and signs on hazardous material storage buildings and other potential hazardous substance production areas should be recognizable.

Along with hazard identification, the three basic levels of response required for potential or occurring hazardous substance incidents help the Awareness Level Responder determine the need for additional resources and thus make the proper notification. Hazardous substance incidents in the shipyard will vary greatly with respect to the potential or realized danger to life and the environment. The response categories (high, medium and low risk) are based on the immediate need for attention, the potential for fire, the existence of injuries and the potential need of evacuation procedures.

First Responders at the Awareness Level are individuals who are likely to witness or discover a hazardous substance release and who are trained to initiate an emergency response sequence by notifying the proper authorities of the release. They would take no further action beyond notifying the authorities of the release. The Awareness Level Responder should report all emergency situation an should provide clear, concise information to the emergency response incident communication system.

Operational Level Responder Training



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National Shipbuilding Research Program
SP-1 Panel

Shipyard Operational Level Responder Training Sessions

Session 1.	Operational Training Introduction To Regulatory Requirements Training Goals And Learning Objectives
Session 2.	Basic Hazardous Substance Terminology and Operational Level Safety
Session 3.	Toxicology Hazards Associated With Hazardous Substances And Emergency Response
Session 4.	Hazardous Substance Management: “In-Control” and “Out-Of Control” Scenarios
Session 5.	Determining the Need For Additional Resources
Session 6.	Facility Emergency Response Planing
Session 7.	Potential Environmental, Health and Safety Outcomes
Session 8.	The Material Safety Data Sheet and Emergency Response
Session 9	Exercise #1. Chemical Hazard Analysis Using An MSDS
Session 10.	Fire/Explosion and Confined Space Hazards
Session 11a.	Personal Protective Equipment (PPE) Awareness
Session 11b.	Personal Protective Equipment (PPE) Awareness
Session 12.	Recognizing and Identifying Hazardous Substances In An Emergency Situation
Session 13.	The North American Emergency Response Guidebook (NAERG96) and Other Information Sources
Session 14.	Incident Hazard Risk Assessment and Initial Response
Session 15	Exercise #2. Incident Hazard Risk Analysis Using MSDS Information and NAERG96
Session 16.	Shipyard Procedures for Incident Control, Containment, and Confinement (Defensive Strategies)
Session 17.	Operational Level Responder Safety In An Emergency Situation
Session 18.	Exercise #3. Incident Control, Containment, and Confinement (Defensive Strategies)
Session 19.	Basic Personal and Equipment Decontamination Procedures
Session 20.	Shipyard Operational Responder Training Summary

Session 1. Operational Training Introduction To Regulatory Requirements Training Goals And Learning Objectives
Session Objectives
To introduce OSHA Emergency Response Regulations, their requirements for training and determining emergency response roles and responsibilities. Objectives also include outlining the training goals and learning objectives of this training program and introducing the course outline.

Session 2. Basic Hazardous Substance Terminology and Operational Level Safety
Session Objectives
To describe common terminology used to describe hazardous substances in the shipyard and to identify safety concerns related to those hazardous substance emergency

Session 3. Toxicology Hazards Associated With Hazardous Substances And Emergency Response
Session Objectives
To illustrate and explain the many dangers associated with hazardous substances and the concepts of toxicology, exposure routes, health effects, dose/response, and lethal concentrations.

Session 4. Hazardous Substance Management: In-Control and Out-Of Control Scenarios
Session Objectives
To provide an understanding about circumstances that describe when hazardous substances management scenarios are “In-Control” or “Out-Of-Control”. Also, explain the “Responsibility to Act” on “Out-Of-Control” hazardous substance situations.

Session 5. Determining the Need For Additional Resources
Session Objectives
To explain the how to determine the need for additional resources and perform internal reporting of hazardous substance related incidents.

Session 6. Facility Emergency Response Planing
Session Objectives
To explain about emergency response planning goals, the purpose and objectives of planning, and the many values and benefits of having an effective emergency response plan.

Session 7. Potential Environmental, Health and Safety Outcomes
Session Objectives
To describe potential risks of adverse health and safety effects, physical property damage, and environmental damage involved with hazardous substance emergency incidents.

Session 8. The Material Safety Data Sheet and Emergency Response
Session Objectives
To explain the importance of the Material Safety Data Sheet (MSDS) in the shipyard and provide an understanding of the information contained in each section and their applications to Operational Level emergency response.

Session 9 Exercise #1. Chemical Hazard Analysis Using An MSDS
Objectives of the Exercise
To provide the Operational Level Responder with the first of three (3) in-class, hands-on, exercises to enhance learning. Another objective involves the information exchange that will take place during the question and answer phase and group discussions.

Session 10. Fire/Explosion and Confined Space Hazards
Session Objectives
To describe fire/explosion and confined space hazardous conditions in the shipyard and explain how those hazardous conditions become extremely dangerous when hazardous materials are involved.

Session 11a. - Personal Protective Equipment (PPE) Awareness
Session Objectives
To describe the different types, materials and selection of Personal Protective Equipment (PPE) worn for hazardous emergency response and/or during daily operations.

Session 11b. Personal Protective Equipment (PPE) Awareness
Session Objectives
To describe the different Levels of Personal Protective Equipment (PPE). This session also describes the variety of materials available for chemical and physical protection equipment and the way in which PPE can be rendered ineffective. The Operational Level Responder will gain a better understanding of their role in emergency response and the role of proper PPE.

Session 12. Recognizing and Identifying Hazardous Substances In An Emergency Situation
Session Objectives
To provide instruction on how to recognize and identify hazardous substances in an emergency situation and understand that responder safety is essential.

Session 13. The North American Emergency Response Guidebook (NAERG96) and Other Information Sources
Session Objectives
To explain the Department of Transportation's (DOT's) 1996 Emergency Response Guidebook (ERG) purpose and use. Also, to explain CANUTEC and Mexico response affiliations.

Session 14. Incident Hazard Risk Assessment and Initial Response
Session Objectives
To describe the process of analyzing incidents to determine the presence of hazardous materials and predicting how the hazard may affect shipyard employees and the environment.

Session 15 Exercise #2. Incident Hazard Risk Analysis Using MSDS Information and NAERG96
Objectives of the Exercise
To provide the Operational Level Responder with the second of three (3) in-class hands-on exercises to enhance learning. The focus is on Operational Level Response methods for using the MSDS and the NAERG96 for incident hazard risk analysis.

Session 16. Shipyard Procedures for Incident Control, Containment, and Confinement (Defensive Strategies)
Session Objectives
To describe the function of hazardous substance incident control, containment and confinement procedures in the shipyard. Also, this session describes the importance of site control zones.

Session 17a. Operational Level Responder Safety In An Emergency Situation
Session Objectives
To provide instruction on how Safety is the first though in a hazardous substance emergency situation and describe a cautious approach with perimeter control.

Session 18 Exercise #3. Incident Control, Containment, and Confinement (Defensive Strategies)

Objectives of the Exercise

To provide the third of three (3) in-class hands-on exercises to enhance learning. The first exercise focused on Chemical Hazard Analysis using the MSDS, which defined the hazards posed by the chemical itself. Exercise #2 focused on a Incident Hazard Risk Analysis, which determined the dangers imposed by the incident on employee health, the environment and shipyard property. This exercise focuses on Operational Level Response initial incident control, containment and confinement actions.

Session 19. Basic Personal and Equipment Decontamination Procedures

Session Objectives

To explain the purpose and the process of personal, area, and equipment decontamination procedures.

Session 20. Shipyard Operational Responder Training Summary

Session Objectives

To summarize the Operations level training program and support the roles and responsibilities of the Operational Responder in the on-site Emergency Response Organization.

Session 1.
Operational Training Introduction To Regulatory Requirements
Training Goals And Learning Objectives

Session Objectives

To introduce OSHA Emergency Response Regulations, their requirements for training and determining emergency response roles and responsibilities. Objectives also include outlining the training goals and learning objectives of this training program and introducing the course outline.

Introduction to Regulatory Requirements

The Occupational Safety and Health Act of 1970 authorizes the Occupational Safety and Health Administration (OSHA) to develop regulations designed to protect employees who work at hazardous waste sites or industrial facilities that may be involved with hazardous substance emergency response activities. OSHA requires all workers, supervisors, and managers who work around hazardous materials and wastes to be trained on methods to protect themselves and respond to hazardous emergency situations. OSHA has developed a standard entitled “Hazardous Waste Operations and Emergency Response" (HAZWOPER) to protect employees in hazardous environments and to help them handle hazardous substances and emergencies safely and effectively.

OSHA HAZWOPER regulations are codified in 29 CFR 1910.120. The regulations encompass voluntary and required clean-up operations at uncontrolled hazardous waste sites; corrective actions involving cleanup operations; operations involving hazardous wastes conducted at TSDF’s; as well as workers responding to emergencies involving hazardous materials and waste incidents. The specific section that applies to most shipyards is 1910.120 (q), which governs the Emergency Response component of the training. Shipyards generally fall under this requirement because certain shipyard employees engage in emergency response and spill clean-up activities. Also, due to the high potential for emergency response actions involving hazardous substances, fires, chemical exposures and environmental contamination, section 1910.120 (q) can apply to shipyard industrial settings.

The regulations require that all training is based on the duties of each responder identified in the facility emergency response plan. The skill and knowledge levels required for all new responders (those hired after the effective date of this standard), shall be conveyed to them through training before they are permitted to take part in actual emergency operations. Employees who are expected to participate in emergency response, shall be given training in accordance with the following table and descriptive sections:

Level of Response Training	General Duties
1) First Responder Awareness Level or Awareness Level Responder	Awareness Level Responders are individuals who are likely to witness or discover a hazardous substance release and who have been trained to initiate an emergency response sequence by notifying the proper authorities of the release. They would take no further action beyond notifying the authorities of the release.
2) First Responder Operations Level	Operational Level Responders are individuals who respond to releases or potential releases of hazardous substances as part of the initial response to the site for the purpose of protecting nearby persons, property, or the

Or ***<u>Operational Level Responders</u>***	environment from the effects of the release. They are trained to respond in a defensive fashion without actually trying to stop the release. Their function is to contain the release from a safe distance, keep it from spreading, and prevent exposure.
3) Hazardous Materials Technicians ***Or*** ***HazMat Technicians***	HazMat Technicians are individuals who respond to releases or potential releases for the purpose of stopping the release. They assume a more aggressive role than a first responder at the operations level in that they will approach the point of release in order to plug, patch or otherwise stop the release of a hazardous substance.
4) Hazardous Materials Specialist ***Or*** ***HazMat Specialist***	HazMat Specialists are individuals who respond with and provide support to hazardous materials technicians. Their duties parallel those of the hazardous materials technician, however, those duties require a more directed or specific knowledge of the various substances they may be called upon to contain. The hazardous materials specialist would also act as the site liaison with Federal, state, local and other government authorities regarding site activities.
5) On Scene Incident Commander ***Or*** ***Incident Commander***	Incident Commanders assume control of the incident scene beyond the first responder awareness level. The Incident Commander is trained to take charge of the incident and control the response through site decontamination and incident review, reporting and follow-up.

Operational Level Training Objectives

Operational Level Responders are individuals who respond to releases, or potential releases, of hazardous substances, as part of the initial response, for the purpose of protecting nearby persons, property, or the environment from the effects of the release. They are trained to respond in a defensive fashion without actually trying to stop the release. Their function is to contain the release from a safe distance, keep it from spreading, and prevent human chemical exposure. Operational Level Responders shall have received at least eight hours of training or have had sufficient experience to objectively demonstrate competency in the following areas in addition to the requirements listed for the Awareness Level Responders:

- Know the basic hazard and risk assessment techniques.
- Know how to select and use proper personal protective equipment.
- Understand basic hazardous materials terms.
- Know how to perform basic control, containment and/or confinement operations within the capabilities of the resources and personal protective equipment available within their unit.
- Know how to implement basic decontamination procedures.
- Understand relevant standard operating procedures and termination procedures.
- Understand that SAFETY is the first thought for responding to a hazardous incident.

Session 2.
Basic Hazardous Substance Terminology and Operational Level Safety

Session Objectives
To describe common terminology used to describe hazardous substances in the shipyard and to identify safety concerns related to those hazardous substance in an emergency

Hazardous Substances Defined

Understanding and identifying hazards associated with handling hazardous materials in the shipyard is very important for environmental health and safety and emergency response. Chemicals are an essential part of our lives, at home and at work, and proper response to spills and other hazardous substance incidents must be considered. Generally, a hazardous substance is any chemical that has the potential for producing harm to human health or the environment. Mishandling or misusing hazardous substances can cause injuries and environmental damage. Proper identification of hazardous materials will help prevent personal injuries or damage to the environment.

Shipyards use several types of hazardous materials for production processes, which often result in the generation of hazardous waste. The substances and associated wastes are considered hazardous because of their chemical, physical or toxic properties. These materials are an integral part of shipyard operations because they are needed to conduct shipbuilding and repair operations. A few examples of these materials are paints, solvents, waste oil, spent blasting media and plating solutions. Due to the concern for employee health, the environment, and the potential for environmental emergencies, the Operational Level Responder must understand the hazardous properties of shipyard chemicals.

What Are Hazardous Materials?

Hazardous materials are a large part of our society which help produces many benefits for increased quality of life. Along with the benefits that hazardous materials provide is the problem of potential accidents that can result in human injury, loss of life, and environmental damage. Because of this risk, the Operational Level Responders must be trained to handle these potential problems in such a manner to minimize injury and environmental damage. In order to handle incidents involving hazardous materials, they must understand what hazardous substances are and how they can cause injury. There is no one definition of a hazardous material. The following describes OSHA, EPA, and DOT definitions.

OSHA A hazardous chemical is any substance to which human exposure results or may result in adverse affects on the health or safety of employees or any chemical which is a physical hazard or a health hazard.

EPA A hazardous substance is any substance designated pursuant to section 31l (b)(2)(A) of the Clean Water Act (CWA) any element, compound, mixture, solution or substance designated pursuant to section 102 of CERCLA, any hazardous waste having the characteristics identified under or listed pursuant to section 301 of the Solid Waste Disposal Act, any toxic pollutant listed under section 307(a) of the CWA, any hazardous air pollutant listed under section 112 of the Clean Air Act and any imminently hazardous chemical substance or mixture with respect to which the EPA Administrator has taken action pursuant to section 7 of the Toxic Substances Control Act (TSCA).

DOT Hazardous materials are substances that have been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce. The term includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials.

Hazardous Properties

Chemicals and hazardous substances can be categorized according to the specific hazards they present. For instance, some chemicals, such as sulfuric acid or caustic soda, cause a burn if they come in contact with human skin. Other chemicals, such as trichloroethane or lead, can cause illness after long term exposure. Still others, such as acetone and toluene, can ignite readily and present a serious fire hazard. The four basic hazard properties are listed below:

Corrosives - Corrosive chemicals can cause the destruction of living tissue, like skin and eyes, during exposure. Similarly, they can cause the destruction of non-living materials such as wood and steel. Corrosives fall into three categories: *acids; bases; and solvents*. Acids cause burns because they react with the proteins, carbohydrates, and fats that compose living tissue. Alkali (caustic) solutions can degrade proteins and fat in the skin leading to desensitization and damaged tissue. Solvents can redden and roughen skin to the point of causing dermatitis.

Toxics - Toxic substances can damage your overall health, either immediately or after some period of time ranging from months to years. Exposures vary depending upon toxicity. Acute toxicity creates an effect that is immediately noticeable or apparent within minutes/hours after the exposure. Chronic toxicity occurs when the response to the exposure is delayed, and may not be noticeable until months or years after the initial exposure. All materials can be toxic. It is the dose that determines the response.

Reactives - Reactive materials can react violently or dangerously with other common materials such as air, water, or themselves (self-polymerizing). Water reactive materials will generate extreme heat and may explode when introduced to water. Air reactive materials will burn vigorously in air, and may also explode. Self-polymerizing materials can burn vigorously in air, and may also explode. Self-polymerizing materials are typically two-part (A/B) systems, that when mixed in disproportionate amounts, generate large amounts of heat.

Flammables - Flammables are materials that pose a hazard because they readily ignite and burn. These chemicals fall into a series of classes depending on their physical characteristics. A *Class I* flammable liquid is any liquid that has a flash-point below 100^{o} F. A *Class II* flammable liquid has a flash-point greater than 100^{o}F. A *combustible* liquid has a flash-point above 140^{o}F. Essentially, flammable chemicals usually can be ignited at normal room temperatures, while combustible chemicals must be heated to their flash-point temperatures before they ignite.

Hazardous Wastes - Hazardous waste is generated when hazardous materials are used and are no longer needed. They usually have one or more of the previous four hazard characteristics and are considered a characteristic waste. Hazardous wastes can also be generated from cleaning-up up a hazardous material spill. Hazardous waste should be labeled properly to provide valuable information to emergency responders in the event of a spill. For all practical purposes, hazardous waste should be treated as a hazardous substance in a emergency incident. If the waste is not labeled, it should be treated as extremely dangerous, (in an emergency situation), until it can be identified further.

Sources of Information for Hazard Identification (Chemical Labels and MSDS s)

The first source of information on the chemical hazards of a substance is the container label. The label will identify the physical hazards, health hazards, safe use instructions, and a number of other important details. Always follow the manufacturer's instructions for storage and use. The second source of information is the Material Safety Data Sheets ("MSDS"). The MSDS will provide detailed information on product hazards and procedures for safe usage, which will be discussed in great detail in a further session. Review the MSDS prior to using any product for the first time and anytime if you are unsure about the hazards or proper safety precautions. MSDS chemical evaluation and hazardous substance labeling will be described in further sessions.

Hazardous Substance Events and Potential Negative Outcomes

Shipyard hazardous substance emergencies have several negative outcomes that can result in injury to initial victims, first responders, employees, and the nearby public. It is important for Operational Level Responders to understand the risks and minimize the potential for putting themselves in dangerous situations. The three main risks associated with hazardous substance emergencies are as follows:

1) **Health**

2) **Fire**

3) **Reactivity**

Hazardous Substances Can Have a Cause Damage to:

- **Employee Health and Safety**

- **The Environment**

- **Shipyard Property and Equipment**

Hazardous substances will never be eliminated completely in the shipyard industrial work-place. Operational Response Level employees must understand that proper usage and response to hazardous substance incidents is the key to minimizing potential negative outcomes.

Operational Level Priorities: The following items form the base of this training program and Operational Responders must ensure that they are competent in their understanding of chemical hazards and their emergency response role.

1. **Safely and Competently Respond within Your Level of Training, Resources and Capabilities!**
2. **Respond Safely, Slowly, and Methodically**
3. **Operational Level Goals**

- Save lives and limit casualties
- Protect the environment
- Limit damage to properties

Session 3. Toxicology Hazards Associated With Hazardous Substances And Emergency Response

Session Objectives
To illustrate and explain the dangers associated with hazardous substances and the concepts of toxicology, exposure routes, health effects, dose/response, and lethal concentrations.

Toxicity, Toxicology and Exposure

"All substances are poisons; there is none which is not a poison. The right dose differentiates a poison and a remedy." (Paracelsus 1493-1541) This basic tenet of toxicology can be simplified as “the dose makes the poison”. Since the dose is the amount of a substance to which a person or other living organism is “exposed”, we can restate the above to say that “the exposure makes the poison”. Hazardous substance exposure can be a serious outcome of an emergency situation. The Operational Level Responder must estimate if they or other workers in the nearby area can be exposed to hazardous substances during an incident.

If there is time, which many incidents do not afford, the specific material safety data sheet (MSDS) is the best source of information to identify the toxicity and exposure characteristics of a hazardous substance. The MSDS provides information about the potential health effects, exposure routes, and dangerous dosages. The following sections identify the definitions and common types of toxicity and toxicological health effects associated with hazardous substances.

Toxicology Definitions	
Toxicology	The study of the harmful effects of chemicals on living things.
Toxic Effects	Undesirable changes in the body because of an exposure to a chemical or hazardous substance. The kind of response (or how severe the response is) depends on the substance toxicity and dosage.
Dose	The amount of the chemical you receive over a certain period of time. **Dose = Chemical Concentration x Length of Time of Exposure**

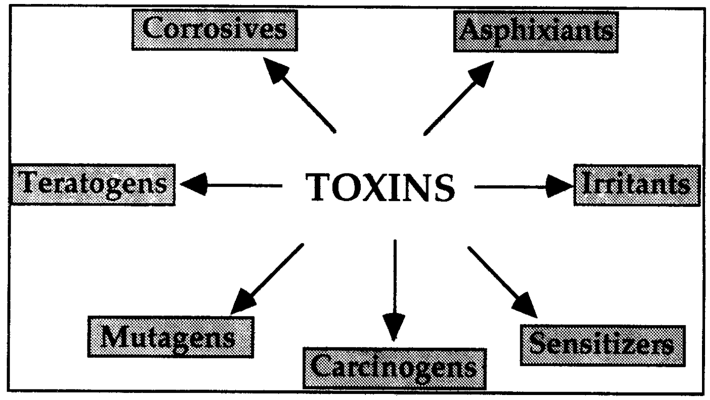
Acute Toxicity: Acute effects occur immediately or in a short interval (minutes to hours) after exposure. They are typically sudden and may be severe (illness, irritation, collapse, and/or death) and are characterized by rapid absorption of the material. Acute exposures are the most common and easiest to recognize (burns, rashes, collapse, unconsciousness) in an emergency situation. They usually occur due to an over exposure to a hazardous substance contacted either through inhalation, skin contact, or through the ingestion. Air and skin related exposures are the most common in emergency response situations.

Chronic Toxicity: Chronic exposure means a relatively low level of exposure that occurs over a relatively long period of time. Chronic effects are usually due to chronic exposures. A chronic effect is one that develops slowly over a period of time or that recur frequently. Chemicals will be considered to cause chronic toxicity if they cause serious irreversible effects.

Hazardous Substance Exposure Health Effects

There are seven (7) types of toxic effects that hazardous substances may have on the body when exposure occurs. These are important to understand in an emergency situation. A single hazardous substance may cause more than one type of effect at the same time.

1. Asphixiants: A *simple asphyxiant* displaces the oxygen in the environment necessary to maintain life. These asphixiants are very important in confined spaces and especially in emergency situations. Examples are: carbon dioxide, ethane, helium, hydrogen, methane, and nitrogen. Another type of asphixiant is a *chemical asphyxiant,* which prevents the uptake of oxygen by the cells of the body. Examples are: carbon monoxide, hydrogen cyanide, and hydrogen sulfide. At high levels, all asphyxiates can cause collapse, unconsciousness, and death.



2. Irritants: An irritant is a material that causes inflammation to a part of the body by direct contact. The two types are respiratory irritants and skin irritants.

Respiratory Irritants	Causes injury to the nose, mouth, throat and lungs. Materials that are very water soluble affect mainly the nose and throat (i.e., ammonia, formaldehyde). Less water soluble materials act deeper in the lungs (i.e., nitrogen dioxide, phosgene).Examples of chemicals that affect both the upper and lower lung are chlorine and ozone. Respiratory tract irritation can be minor, such as a tightening of the chest or bronchitis, but it may also be very serious, as in the case of pulmonary edema, which can cause death.
Skin Irritants	May cause contact dermatitis, a redness, itching and drying of the skin. Examples are organic solvents and detergents. Very corrosive agents, such as chromium and nickel, can cause skin ulcers and destroy tissue.

3. Allergenic Sensitizers: After repeated exposures to certain chemicals, some individuals experience an allergic or immune reaction. Allergic sensitizers generally affect the skin and respiratory tract. The symptoms are often the same as those caused by irritants. Examples of such symptoms include dermatitis or bronchitis. As with irritants, the response may be very serious, and may even cause death. Examples include: isocyanates, phenol resins, and epoxy resins.

4. Systemic Toxins (5 Internal Poisons)

Blood System (Hemolytic) Toxins	These toxins damage blood cells or interfere with blood cell formation. Examples include benzene, methylene chloride, arsine, phosphorus, and naphthalene.
Nervous System (Neuro) Toxins	These toxins damage the nervous system. Typical symptoms include dullness, muscle tremor, restlessness, convulsions, loss of memory, epilepsy, and loss of muscle coordination. Examples include mercury, insecticides, hexachlorophene, and lead.
Liver (Hepato) Toxins	These toxins cause liver damage, including jaundice and liver enlargement. Examples include alcohols and carbon tetrachloride.
Kidney (Nephro) Toxins	These toxins damage the kidneys, causing swelling and increased serum proteins in the urine. Examples include halogenated hydrocarbons and heavy metals.
Reproductive Cell (Gameto) Toxins	These toxins damage the reproductive cells (egg and sperm) or interfere with their formation. Examples include lead, cadmium, cellosolves, and vinyl chloride.

5. Carcinogens: Carcinogens are chemicals that are known to cause cancer in humans or animals. Cancer is the uncontrolled growth of malignant (harmful) cells at any site in the body. The development of cancer may be delayed for 20 to 30 years after the exposure. Examples of carcinogens include vinyl chloride, asbestos, ethylene dibromide, and toluene.

6. Teratogens: Chemicals are classified as teratogens and reproductive toxins if they affect the ability to conceive, bear or nurture offspring and anything that influences the function or viability of sperm cells. Teratogens are toxins that cause physical defects in a developing embryo or fetus. In the 1960s methyl mercury was the first industrial chemical shown to be a teratogen. Other examples include thalidomide, some types of anesthetic gases, and ionizing radiation.

7. Mutagens: Mutagens are toxins that cause a change (mutation) in human genetic material. Mutation of the reproductive cells may cause birth defects in future children. Mutation of other cells in the body may cause cancer or defects in developing embryos or fetuses. Examples include ethylene oxide, benzene, hydrazine, and ionizing radiation.

Exposure Routes

The concept of exposure routes is very important for the shipyard Operational Level Responders because of their need to recognize a hazardous situation where exposure can be extremely dangerous or even fatal. The term exposure is important as well as the understanding of the relationship between exposure and the route. Exposure is dependent upon the degree that a substance, comes into contact with surfaces of the organism capable of absorption. Exposure is very similar to the term dosage. There are basically three surfaces associated with human exposure and they are related to the three exposure routes.

Exposure Route	Absorption Site
1. Inhalation	**Lungs** by inhalation (breathing in) and absorption through the lung walls into the body
2. Dermal	**Skin** by direct contact and absorption through the skin into the body (also eyes)
3. Oral	**Digestive tract** by ingesting (swallowing) substances into the body digestive tract or gastrointestinal (G.I.) tract

Note: The route of exposure can result in different rates of absorption and different toxic effects. Exposures can be controlled by using proper personal protective equipment (PPE).

1. - Inhalation Exposure (The Lung Exposure Route): Inhalation exposure is the most common way that hazardous substances enter the body, especially in an emergency response situation. The lungs are the largest exposed surface area of the body and facilitate the transfer of gases into and out of the body. If your alveoli (the tiny sacs at the bottom of the lungs) were flattened out, they would cover an area the size of a tennis court. This huge surface area is only one single cell thick, which allows a chemical to travel into the bloodstream quickly. The large surface area results in rapid absorption and rapid excretion if the gas is not bound to tissue. Similarly, particulate compounds may be deposited in different areas of the lungs depending on the particle size, with the smallest particles penetrating the furthest. Once deposited, particulates in the lunges can either have an acute or chronic toxic effect. Some materials have good “warning properties,” such as odor or immediate difficulty with breathing, which enables individuals to know when they are being exposed.

2. - Dermal Exposure (The Skin Exposure Route): The skin is a specialized organ that provides a barrier between the environment and internal organs. The skin is not highly permeable and provides good protection against most compounds. Although, a small amount of toxicants can enter through the hair follicles and sweat glands, the majority of chemicals must pass through the densely packed skin cells and into the blood stream. Contact with a chemical substance by the skin is called dermal contact and may cause two major effects: 1) Local Effects and 2) Systemic Effects

1) Local Effects:	
Irritation	Many chemicals cause an immediate reddening, rash, or other irritation to the skin upon contact.
Tissue damage	Chemicals such as corrosives, including acids or bases, eat into the skin and cause damage to the tissue beneath it.
Allergic effects	Some chemicals, such as nickel, chromium, formaldehyde, turpentine, and isocyanates, cause the skin to become hypersensitive after repeated exposures. This is called sensitization dermatitis.
2) Systemic (internal) Effects:	Systemic effects from absorption through the skin. Many solvents are absorbed through the skin, circulated through the bloodstream, and then cause damage within the body.

3. - Oral Exposure (The Digestive Tract Exposure Route): The gastrointestinal (G.I.) tract can be thought of as a tube going through the body. Chemicals that are eaten, intentionally or accidentally, may be absorbed into the body through this "tube" where acute and/or chronic toxic effects can occur.

Dose/Response Relationship

The dose/response relationship is the basis for measuring toxicity and the study of toxicology. The obvious assumption simply states that for the dose/response relationship to be valid, increasing the dose should result in an increased toxic response.

Example of the Dose/Response Concept:

Dose = Concentration	Time	Response
1 quart of 12% ethanol (alcoholic beverage)	15 min.	brain effects ("drunk")
1 quart of 12% ethanol	daily	chronic organ damage
1 quart of 12% ethanol	annually	no observed effect

Note: The same dose given over a short period of time may have a substantial effect, while the same dose over a long period of time may have no effect at all.

Immediately Dangerous to Life and Health (IDLH)

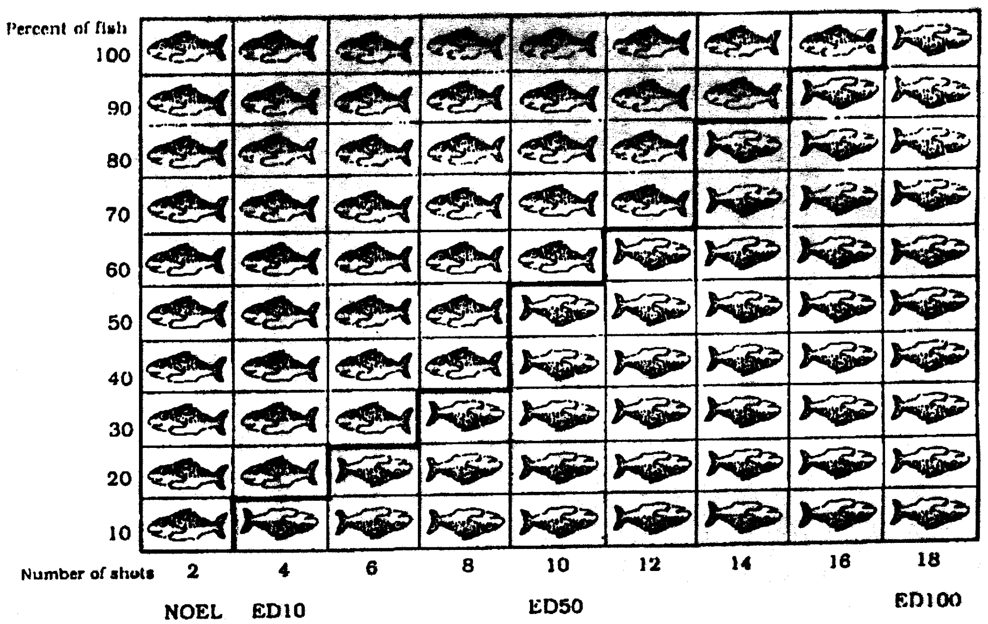
The IDLH is defined as the concentration of airborne contaminants that represents the maximum level (dosage) that an individual could not escape within 30 minutes without any escape-impairing symptoms or irreversible health effects (response). This level is established for a wide verity of hazardous substances by both the National Institute of Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH).

Lethal Dosage and Concentration

The simplest toxicology study relates the percentage of test animals that die (mortality response) from the dose given. The dose is usually expressed in mg/kg for ingestion or inoculation, in mg/M^2 for skin exposure, or in mg/M^3 for inhalation. The response is expressed in percent (%) of animals

that have died. The dose of a chemical that kills 50% of the test animals is the LD-50. The chemical may be given by mouth (oral), applied to the skin (dermal), or injected (parenteral). Lethal concentration 50 percent (LC-50) is usually expressed in parts per million in air. It is the concentration that kills half the population of the test animals in a given observation period. It is independent of body weight. The LC-50 measurement is used to determine the toxicity of vapors, fumes and dusts in air. The test procedure is very similar to LD-50 tests. The lethal dosage and concentration measures acute toxicity and is commonly used to measure relative toxicity. The important thing for hazard awareness is the understanding a low LD-50 value means that the chemical is more toxic, (i.e. 1 mg/M^3) while a high LD-50 (i.e. 10,000 mg/M^3) indicates a less toxic chemical.

An example of the dose/response relationship is illustrated by dumping shots of I00-proof whiskey into a ten-gallon tank containing ten goldfish. How many shots (dosage) will cause the fish to swim upside down. After one or two shots, none of the fish die, but after about four shots, one of the fish dies. As more shots of whiskey are added, more fish, begin to die. After ten shots, five of the ten or 50% of the goldfish are swimming upside down. If the effect being observed is death, then the lethal dosage (LD50) would be the measure of the lethal dose for 50% of the population.



Emergency Response Planning Guide (ERPG)

Hazardous concentrations have been developed for emergency response situations where response individuals may be exposed for short periods of time. These ceiling limit values are developed and recommended by the American Industrial Hygiene Association (AIHA). The ERPG limits are not intended for repeated or extended exposures. There are 3 different levels are defined as follows:

ERPG-1: Maximum airborne concentration to which nearly all individuals could be exposed for up to one hour without experiencing or developing health effects more severe than sensory perception or mild irritation.

ERPG-2: Maximum airborne concentration below which, it is believed, nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible adverse or other serious health effects of symptoms which could impair an individual's ability to take protective action.

ERPG-3: Maximum airborne concentration below which, it is believed, nearly all individuals could be exposed for up to one hour without experiencing or developing life threatening health effects.

Session 4.
Hazardous Substance Management:
In-Control and Out-Of Control Scenarios

Session Objectives

To provide an understanding about circumstances that proscribe when hazardous substances management scenarios are "In-Control" or "Out-Of-Control". Also, explain the "Responsibility to Act" on "Out-Of-Control" hazardous substance situations.

Hazardous Substance Management In-Control Vs. Out-of-Control

All chemicals can be used and manages safely if you understand the hazards and follow proper procedures of hazardous material management. The shipyard has initiated procedures and practices to control hazard material usage, storage, transportation and disposal. These procedures are in compliance with safety and environmental regulations. When hazardous substances are used or managed properly, the material is usually "In-Control". In contrast, when a material is improperly managed, the substance is "Out-of-Control". When hazardous materials are managed poorly, the potential for accident is higher and the potential outcomes for the hazardous incident are intensified. The examples in the following table describe the difference between proper hazardous materials management and poor hazardous materials management.

Condition	In-Control Example	Out-of-Control Example
Storage	Contained area with warning signs. Materials stored by computability.	Uncontained area with a potential pathway to humans or the environment No visible signs.
Transportation	Secured load in original containers.	Loose loads, lids, with potential spillage.
Container Labeling	Original condition.	Missing labels with no replacement
Container Type and Condition	Original container with no damage Other approved compatible container.	Damaged container with potential or actual spillage of material. Improper or incompatible container.
Usage	Proper PPE and contained area, continuous attention, lids on containers.	Improper or limited PPE. Materials frequently left unattended.

Out of Control Management Practices Can Result in Dangerous Incidents

The shipyard Operational Level Responder must understand the basic hazards associated with hazardous substances and realized that those hazards can be kept under control with proper management practices. When a hazardous substance becomes out-of-control, actions must be taken to manage the potential problems. By determining the proper hazardous substance control practices, the Operational Level Responder can determine the actions to be taken to rectify a potentially hazardous situation or an actual incident. For example, if secondary containment is to be used for the normal practices and none is applied, then secondary containment will be a requirement of controlling the hazardous substance incident.

For example, if a spill occurs in an uncontained area where the employees do not have proper PPE, the outcome of the incident could result in substantial employee contaminations and environmental releases. On the other hand, if the materials were managed “In-control,” the shipyard work-area would be contained (berm, liner, etc.) from the environment and the employees would be protected by their PPE. Frequent inspections, area evaluations, and corrective actions are the keys for keeping hazardous substances “In-control”. Ensuring proper “In-Control” management of hazardous substances in the shipyard is the basis for pollution prevention and employee health and safety.

Understand The Responsibility to Act and To Evaluate Hazard Severity

It is the responsibility of the First Responder Operational Level to make a hazard determination take actions to minimize personal contamination and initiate the emergency response sequence by notifying the proper on-site authorities of the release or threatened release of hazardous substances.

Hazard Identification	Action
Is the situation an environmental and safety concern and what level of severity is the situation	The First Responder Operational Level Is “Responsible to Act” 1. Hazard Severity Identification 2. Make the Required Notification

It is important that the Operational Level Responder has an understanding of the severity of the incident or potential incident. This understanding will help determine the appropriate level of response when the environmental incident is reported. The levels of severity for Operational Level Response consideration can include the following:

A) Low Severity Hazard Identification	Operational Level Responder Actions
- Small amount (< 1 gallon) of low hazard substances - Small potential for human or environmental contamination - No potential for fire or explosion	1. Make appropriate shipyard notifications 2. Secure the area to prevent employee or environmental exposure 3. Wait until help arrives

B) Medium Severity Hazard Identification	Operational Level Responder Actions
- Medium amount of low hazard (i.e. low flammability) substances (>1 and < 5 gallons) - Small amount of highly hazards substances (i.e. highly corrosive, toxic, flammable, etc.) - Some potential for human or environmental contamination - No Potential for fire or explosion	1. Secure the area to minimize the potential for employee or environmental contamination 2. Make appropriate shipyard notifications 3. Wait until help arrives

C) High Severity Hazard Identification	Operational Level Responder Actions
- Any amount of extremely hazardous substance - Medium amount of highly hazardous substances (i.e. highly corrosive, toxic, flammable, etc.) - Large amount of hazardous substances (> 5 gallons) - High potential for human or environmental contamination - Any potential for fire or explosion	1. Attend to employee contamination if safe to do so (judgment call) 2. Secure the area to minimize the potential for employee or environmental contamination 3. Make appropriate shipyard notifications 4. Wait until help arrives

Session 5.
Determining the Need For Additional Resources

Session Objectives
To explain the how to determine the need for additional resources and perform internal reporting of hazardous substance related incidents.

Determining the Need for Additional Resources

Hazardous substance incidents in the shipyard will vary greatly with respect to the potential or realized danger to life and the environment. For example, if a person is injured and a hazardous substance is involved, this requires a substantially different response than a situation where a container of paint has a potential of being spilled. In general, spill hazards and hazardous substance emergencies in the shipyard fall into one of three response categories. The response categories are based on the immediate need of attention, the potential for fire, the existence of injuries and the potential need of evacuation procedures. These three levels of hazard substance incidents are described in the following table:

Response Level	Example Situation
1. High Risk - Immediate Danger with Injuries	- All immediate employee health problems (collapse, vomiting, burning, blinding, etc.), with exposure to a hazardous substance. - All fires in the shipyard (identify if hazardous substance may be present). - All spills that are released into nearby waters. - All spills of flammable substances in a confined area or space. - All incidents involving extremely flammable substances or extremely toxic or corrosive substances. - All accidental compressed gas releases or the immediate threat of a compressed gas release.
2. Medium Risk - Spill With Other Potential Dangers	- All spills of hazardous substances in significant quantities (>5 gallons) - All spills of high toxicity substances. - All spills that are not causing an immediate health problem, but have a potential to expose employees. - All spills that are not causing an environmental release, but have a potential to be released to the environment.
3. Low Risk - Small Spill or Potential Spill or Other Hazardous Substance Condition	- All small incidental spills of 1 gallon or less of low toxicity substances (i.e. paints) with no potential to be released into local waters. - All potential conditions that pose a threat to employees or to the environment. For example, an open can of paint on the edge of a pier.

Risk determination is usually conducted by taking the following four variables into account:

1) The employee exposure present or potential
2) The hazards or toxicity level associated with the hazardous substances involved
3) The volume of the hazardous substances involved
4) The location of the spill - area access, ventilation, immediate pathway to surface water, access to clean-up materials

Emergency Response Individuals and Their Resources

The shipyard has several levels of resources (i.e. responders) to apply to hazardous substance emergencies or incidents. It is important that the right resources are used to respond to the incident. It is always better for the Operational Level Responder to initiate a response that may require greater resources that to notify for a lesser risk situation. ***In other words, it is better to err on the safe side and have too many resources than to not have enough to handle the incident.***

Response Individual	Emergency Resource Functions
Hazardous Materials Technicians Response Level	Respond to releases or potential releases for the purpose of stopping the release in order to protect employees and the environment. They assume a more aggressive role than a first responder at the operations level in that ***they will approach the point of release in order to plug, patch or otherwise stop the release of a hazardous substance.*** If they are trained fire fighters, they will perform functions to control ignition and perform life saving functions as necessary.
Hazardous Materials Specialist Level	Respond with and provide support to hazardous materials technicians. Their duties parallel those of the hazardous materials technician, however, ***their duties require a more directed or specific knowledge of the various substances*** they may be called upon to contain. The hazardous materials specialist would also act as the site liaison with Federal, state, local and other government authorities regarding site activities. In a shipyard setting, this individual can be a member of the Environmental Department or the Safety Department.
On Scene Incident Commander Level	Incident commanders will ***assume control of the incident scene*** beyond the First Responder Awareness Level. Once the incident is reported, the On-Scene Incident Commander will take over and organize all activities to respond to the incident at hand. The On-Scene Incident Commander will identify the exact required resources and notify off-site response companies or agencies when necessary.
Outside Clean-up Contractors, and Local State, and Federal Agencies	The shipyard is prepared with an on-site as well as off-site emergency response organizations or resources able to respond to hazardous substance emergencies and spill clean-ups. The on-site emergency response resources are capable of resolving most common situations in the shipyard although, in extreme cases that warrant off-site assistance, the Incident Commander will be the individual in charge of requesting assistance from off-site response companies and/or agencies.

Two Shipyard Examples:

A spill of a low hazard material, in a small amount, (i.e., a few gallons or less of hydraulic fluid), in a location that is not an immediate threat to people or the environment, can be cleaned up by *First Responder at the Operations Level*. On the other hand, a large volume spill of a high hazard material, (i.e., a 55 gallon drum of flammable solvent), in a location where people or the environment maybe injured, requires a quick response by individuals trained at a minimum of the *Hazardous Materials Technicians Response Level.*

General Role the Shipyard Operational Level Responder

Operational Level Responders are a very important part of shipyard emergency and environmental incident response plan. Operational Level Responders are general workers in the shipyard who are likely to witness or discover some of the following situations:

- Hazardous substance emergencies or potential emergencies
- Hazardous substance releases to the environment
- Personal chemical contaminations

- Potential releases to the environment (a open can of hazardous substance on a pier)
- Small spills or container with immediate spill danger left unattended
- Fires or burning operations near hazardous substances

Operations Level Responders are individuals in the shipyard who ***respond to releases or potential releases of hazardous substances as part of the initial response. They respond for the purpose of protecting nearby persons, property, and/or the environment from the effects of the release.*** They are trained to respond in a defensive fashion without actually trying to stop the release. Stopping the release will be viewed as a secondary responsibility for the Operational Level Responder and seen as the primary responsibility of the Hazardous Materials Technician Level Responder. ***The Operations Level Responders main function is to contain the release to a specific area and keep shipyard workers at safe distance, therefor keeping the hazardous substance from spreading, and prevent personal exposures.***

Shipyard Operational Level Responders will perform emergency notification for all types of emergencies including but not limited to the following:

- Injury accidents.
- Fires.
- Smoke from unidentified sources.
- Personal chemical contamination.
- Environmental pollution.
- Dangerous hazardous materials handling.
- Confined space spills or accidents.

Incident Response Notification System

In spite of all precautionary measures, environmental and hazardous incidents may occur. The Operational Level Responder should be able to identify these problems and associated exposure and environmental risks. ***The shipyard emergency response organization and resources will have protection of human health and safety as its primary objective during all shipyard hazardous substance incidents.***

In most instances, the shipyard emergency response system will be initiated by a telephone report from a shipyard worker, Awareness Level Responder, or an Operational Level Responder. When reporting a spill or other hazardous materials incident to on-site Security, Fire, Safety or Environmental Department, the caller should be prepared to provide as much information as possible, including any information about the hazardous substances and potential environmental or human contamination.

Call the on-site security or emergency response (i.e. fire department) and give them the required information and need for additional resources.

Report the Following Information:

1) Caller's name and badge number.
2) The location and extension from which you are calling.
3) Description of the incident (i.e., spill, leak, fire, and injuries, etc.).
4) Description of hazardous substances involved.
4) Location of incident (Building Number, Deck, Frame Compartment, etc.).
5) The need for additional resources.
6) Other relevant information.

Clear, calm and accurate emergency notification will result in a fast appropriate response. The Shipyard Operational Level Responder should stay on the line until advised otherwise.

Session 6.
Facility Emergency Response Planning

Session Objectives
To explain about emergency response planning goals, the purpose and objectives of planning, and the many values and benefits of having an effective emergency response plan.

The Shipyard Emergency Response or Contingency Plan

A comprehensive program aimed at prevention of injuries, fire and environmental incidents has been implemented throughout the shipyard to ensure employee health and safety and environmental protection. If, in spite of all precautionary measures, a hazardous substance incident should occur, the shipyard is prepared with an on-site emergency response plan and organization. If the situation is extremely severe, the on-site emergency procedures dictate the assistance from off-site response companies or agencies. In all incidents, large or small, the emergency response team will have protection of human health and safety as its primary objective.

Emergency Response Plans are developed and implemented by shipyards for environmental compliance and protection of employees and the environment. The emergency response plan is generally a written portion of the shipyard safety and health program. Similarly, a Contingency Plan is a RCRA required document that sets out how hazardous waste generators (i.e. shipyards) will respond to emergency situations. The Contingency Plan is very similar to an emergency response plan in that it establishes procedures to minimize potential hazards imposed by explosions, fires, and releases of hazardous substances to the air, soil, or water. Shipyards generally have emergency response plans that are required by, or prepared in conjunction with, Superfund Amendment and Reauthorization Act (SARA Title III Section 302) and Emergency Planning and Community Right-To-Know Act (EPCRA). Employers who will evacuate their employees from the work-site location when an emergency occurs, and who do not permit any of their employees to assist in handling the emergency, are exempt from some response plan development requirements.

A delayed or improper response to an incident involving hazardous substances, such as spills, leaks, fire and/or explosions, can cause a severe effect on the environment (land, water and air). To prepare for such incidents, shipyards develop and implement emergency response plans. The emergency response plan usually includes the following information:

- Notification system for hazardous substance emergency incidents
- Procedures to follow if an emergency occurs
- Evacuation routes and gathering areas in the shipyard
- On-site emergency equipment and response personnel
- Pre-emergency planning and coordination with outside parties
- Personnel roles, lines of authority, and communication
- Emergency recognition and prevention
- Safe distances and places of refuge
- Site security and control
- Decontamination procedures
- Emergency medical treatment and first aid
- Emergency alerting and response procedures
- Critique of response and follow-up
- Personal Protective Equipment (PPE) and emergency equipment

Goals of Emergency Planning

The ultimate goals of the shipyard's hazardous materials response should be prioritized and stated in the plan. The goals and priorities should generally take the following order of priorities:

1) **Life and health** - First consideration to responders, persons needing rescue, other employees.

2) **Environment** - Actions taken need to consider potential environmental releases before property.

3) **Property** - Protection of shipyard property is important, although last priority.

It is important to understand the general purpose of planning. Planning is an important part of the response plan itself. The emergency response plan is the end result of the emergency response process of planning. The process of planning for hazardous incidents represents a first step toward an effective response. The four basic steps of shipyard planning and emergency plan development are:

Step 1. Identify all potential hazardous materials dangers on-site from handling and storage, to processing.

Step 2. Identify all available and required resources from within the company and outside through mutual aid agreements or private contractors.

Step 3. Determine training and equipment needs necessary to develop in-house emergency response capabilities.

Step 4. Validate the plan by conducting emergency response exercises. Start with table top exercises, then partial-functional exercises, and graduate to full scale exercises involving the public agencies.

Objectives of Emergency Planning

There are four main objectives to consider in shipyard emergency response planning:

1) Preparedness Once the plan is developed, it must be continually reviewed and updated, trained to, and exercised.

2) Response Actions needed for responding to the emergency. Implementation of the incident action plan.

3) Mitigation Methods used to contain or control the release. Some companies have developed standard operating procedures to control releases or shutdown a process. The later is known as emergency shut-down procedures.

4) Recovery The process of restoring a production area or bringing a process back on line. Recovery may include decontamination of the affected area and proper disposal of wastes. An investigation of the incident to determine root cause should be conducted prior repairing equipment or rebuilding a process area.

Benefits of Good Planning

The ultimate value and benefits of good planning put responders in a proactive, rather than a reactive, response mode. A reactive response mode will be unorganized and may result in miscommunication and injury to employees and responders. The specific value and benefits of planning generally include:

Benefits	Description
Proactive Response	Reduces the time spent reacting to crisis and makes better use of time preventing an increased crisis.
Incident Prevention	Reduces risks by eliminating or reducing conditions which may cause an incident.
Hazard Analysis	A process that identifies hazards and evaluates risks. The goal is to eliminate unknowns and institute "In-Control" management.
Encourages Involvement	Includes personnel from within the company and companies or agencies that may respond to an emergency. The results are buy-in for the plan from company personnel and establishing a positive relationship with the community, and local, state and federal agencies.
Contingency Assessment	Evaluates personnel, equipment, and training needs. The pre-plan should consider the responder's level of training, resources, and capabilities. Are they adequate for the shipyard facility conditions?
Incident Management	Good management personnel and systems are important to the successful conclusion of any incident.

Session 7.
Potential Environmental, Health and Safety Outcomes

Session Objectives
To describe potential risks of adverse health and safety effects, physical property damage, and environmental damage involved with hazardous substance emergency incidents.

Hazardous Materials Events Have three Main Risks and Potential Negative Outcomes

The Operational Level Responder must understand that hazardous substance emergencies have potential negative outcomes on human health, the environmental and shipyard properties. The risk of hazardous substance exposure for responders and other employees must be understood. A potential hazardous substance emergency exists when a hazardous substance involves with:

- Personal hazardous substance exposures (improperly protected employees)
- Potential pollution of the environment (out-of-control hazardous substance management)
- Confined space entry and working conditions (special cautions in confined spaces
- Fire, welding and source of ignition (extreme explosion/fire hazard in flammable atmospheres)

The Operational Level Responder is trained to understand the potential outcomes and the intensified dangers associated with an emergency when hazardous substances are present. Negative outcomes can result in injury to initial victims, first responders, employees, and the nearby public. Hazardous substance emergency potential negative outcomes and associated priorities are as follows:

1) Potential Life-Threatening Injury From Toxic Exposure (First Priority)
2) Potential Environment Damage (Second Priority)
3) Potential Property Damage From Fire and Explosion (Last Priority)

1) Potential Life-Threatening Injury From Toxic Exposure

To fully understand the potential dangers involved with a hazardous materials incident, it is necessary to examine the definition of toxic exposure and what it can mean. For example, a toxic substance can be small amounts of a material that are life threatening and for that reason, should be considered very dangerous. These very dangerous situations can occur in the shipyards and Operational Level Responder must be very cautious. The Operational Level Responder must understand that all hazardous materials should be considered to be toxic and dangerous, especially in an emergency incident, until their identity and hazards can be further defined.

Exposure of Operational Level Responders in an emergency situation usually occurs through inhalation because the responder rushes in to help a victim. The hazardous material is inhaled into the lungs where it can injure the respiratory tissues and/or enter the blood stream. The effect of inhalation exposure can be devastating and life threatening. Operational Responders should never rush into a hazardous substance incident, until the potential exposure can be determined.

The second most common route of chemical exposure is through skin contact. Skin exposure can be very dangerous because of the amount of time the substance may stay on the skin prior to

decontamination. This increased time-frame exposure can result in a potential increase in dosage. Skin exposure is usually the result of handling a victim or containers without proper PPE. The Operational Responder should never rush in and touch contaminated surfaces (including the victim) without proper PPE.

Operational Level Responder: Safety Is The First Thought
There are many important reasons to understand the hazards of chemical substances in the shipyard. As the shipyard Operational Responder, an extra level of understanding and safety precaution is required. The shipyard Operational Level Responder must understand the following:

- Hazardous substances can hurt you and the environment
- Chemicals pose different types of hazards
- There are "correct" and "incorrect" ways to handle chemical incidents
- Responding to spills and other hazardous Incidents requires extreme caution
- Treat all "unidentified" hazardous substances as extremely dangerous and lethal
- Confined spaces and hazardous substances are a unique and highly dangerous combination
- Correct hazardous substance information and understanding is the key to a safe response

Protection of Human Health and Safety is the Operational Level Responder s First Priority!

2) Potential Environmental Damage

All hazardous substances can cause damage the environment. The environment is considered to be the "air we breath, the land we live on, and the water we drink, fish, and swim in". It is important to understand that the contamination of the environment will have an adverse affect on employees, communities and the population in general. Pollution pathway analysis with respect to local environmental surroundings is an important concept to understand when considering potential for environmental damage.

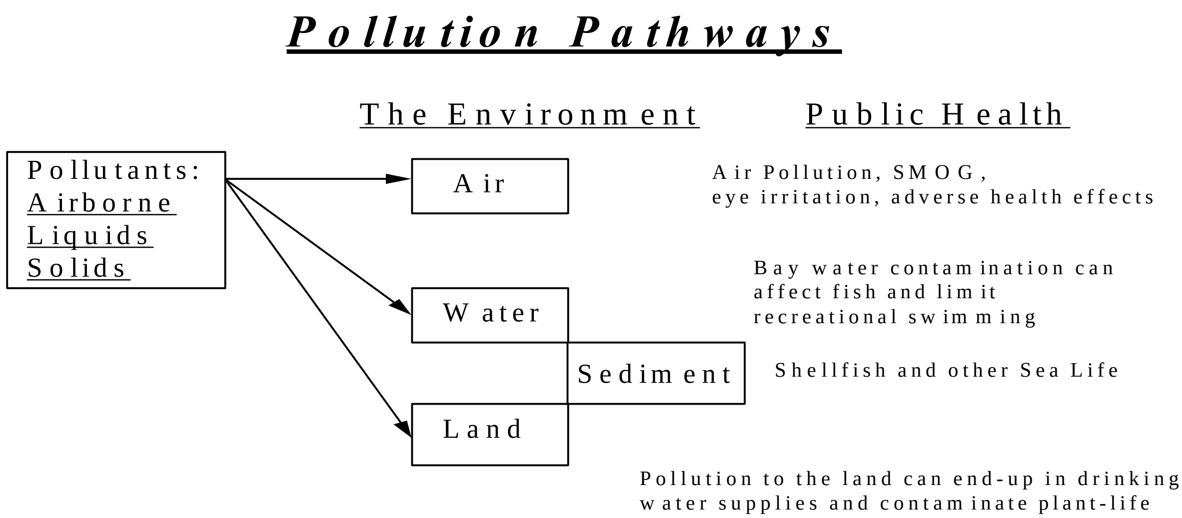
Operational Level Response employees must be aware of possible hazardous substance environmental pollution pathways. Storm drains are located throughout the shipyard. All storm drains discharge to adjacent surface waters. It is important for the Operational Level employee to understand the various types of hazardous substances and their potential pathways.

Within the shipyard there are a variety of hazardous materials that can be transported to surface waters, the ground, or to air if an accident should occur. Accidents involving chemical or hazardous substances can occur at any time or place in the shipyard. Areas that pose a significant risk are those that have direct pathways leading to adjacent surface waters and involve hazardous substances that include but are not limited to those listed in the following table:

Liquids	Solids	Airborne
Paints, Solvents, Fuels, Oils, Waste Water	Blast Materials, Grease, Salts, Cans, Containers, Liquid Containers, Solid Sludge	Paint Over-Spray, Grit Blast, Dust, Volatile Organic Compounds (VOC's), Welding Emissions, Wind Blown General Trash, Etc.

Note: Major pathways to the waters are storm drains, utility trenches, direct runoff channels, direct dumping of waste overboard, freeports, scuppers and drains on piers and ships, and unsealed manholes.

The following figure identifies a multimedia approach towards pollution pathway analysis:



Protection of the Environment is the Operational Level Responder Second Priority!

3) Potential Property Damage

The potential damage to shipyard property is the least important factor for Operational Level Responder to consider once a hazardous substance incident is in process. Most property damage results from hazardous materials that ignite and burn under certain conditions. Emergencies that involve fires are very dangerous and deserve special attention. The Operational Level Responder must understand that combustion is a chemical reaction between two substances, one of which is usually a shipyard structure and/or the chemical itself.

There are two primary methods of preventing property damage from fires and explosions. First is to prevent the fire or explosions occurrence through proper management practices and fire extinguishing equipment. The second is to maintain levels flammable vapors below the Lower Exposure Limit with adequate ventilation.

Always remember that people in an area with unsafe levels of flammable vapors must evacuate until the vapor concentration is reduced to a safe level. Once a fire has started, employee safety is the first priority, environment is the second priority and the shipyard structures and property are the last priority.

Protection Shipyard Property is the Operational Level Responder Last Priority!

Session 8.
The Material Safety Data Sheet and Emergency Response

Session Objectives
To explain the importance of the Material Safety Data Sheet (MSDS) in the shipyard and provide an understanding of the information contained in each section and their applications to Operational Level emergency response.

Introduction to the MSDS

The Material Safety Data Sheet (MSDS) is the primary source of technical information concerning safe handling procedures and health affects of a chemical or product. According to OSHA's Hazard Communication Standard (HCS) regulations, a MSDS must be readily available near the work station for every hazardous chemical used. Employees must know how to obtain an MSDS and must be trained on how to interpret them. Since the central role of the MSDS is to provide hazardous material safety information, it is important that the Operational Level Responder understands how to read an MSDS effectively.

This training session provides a section by section review of the MSDS and the type of information that must be provided by companies furnishing MSDS's. Although, the format of many MSDS may be somewhat different, each MSDS must contain all elements of the required data. The following table provides an outline of a typical MSDS and the subjects contained in each section:

MSDS SECTION	OUTLINED INFORMATION
SECTION I - MANUFACTURER / PRODUCT IDENTIFICATION	Product name Address of the manufacturer, importer or other party responsible for preparing the MSDS. Emergency and non-emergency telephone number. The date the MSDS was prepared or last changed.
SECTION II - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION	Hazardous chemical names. Chemical identity, CAS # and concentration (%) in the product. OSHA PEL limits in air. ACGIH TLV limits in air.
SECTION III - PHYSICAL/CHEMICAL PROPERTIES	Vapor density Melting point or range Specific gravity Boiling point or range Solubility in water Appearance and odor Warning properties
SECTION IV - FIRE AND EXPLOSION HAZARD DATA	Flash point Autoignition temperature Lower explosive limit (LEL) Upper explosive limit (UEL) Special fire fighting procedures Fire extinguishing materials Unusual fire and explosion hazards
SECTION V - HEALTH HAZARD INFORMATION	Symptoms of overexposure for each route of exposure How to recognize exposure Acute and chronic effects of exposure First Aid Emergency Procedures for exposure Suspected carcinogens (yes or no)

	Medical conditions aggravated by exposure
SECTION VI - REACTIVITY DATA	Product stability Conditions to avoid Materials to avoid Hazardous decomposition Hazardous polymerization
SECTION VII - SPILL LEAK AND DISPOSAL INFORMATION	Spill response procedures Proper disposal of spilled wastes
SECTION VIII - PRECAUTIONS FOR SAFE HANDLING AND USE	Ventilation and engineering controls Respiratory protection Eye protection Clothing and equipment Hand protection (gloves) Good work practices Decontamination of equipment Handling and storage requirements
SECTION XI - LABELING	DOT shipping name Precautionary statements NFPA hazard rating

The following nine (9) sections describe the MSDS sections, outline information presented, and identify key terms.

SECTION I - MANUFACTURES IDENTIFICATION

The first section of the MSDS contains the name and address of the chemical manufacturer, importer or party responsible for preparing the MSDS. Both emergency and non-emergency telephone numbers are provided for obtaining additional information on the hazardous product. The date that the MSDS was prepared or last changed should also be included in this section.

The most important information contained in this section is the emergency information phone numbers. This gives the caller access to an individual that should be educated about the product and associated health risks, clean-up procedures, and personal decontamination. The person at the emergency phone should be able to clarify the information provided on the MSDS over the phone.

SECTION II - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

Any chemical substance that has been found to present a physical or health must be identified on the MSDS by its specific chemical name and its common name. Chemical mixtures that have been tested as a whole, and have been determined to be hazardous, must be listed by the chemical and common names of the components that contribute to the hazard(s), as well as the common name(s) of the mixture itself. Mixture ingredients which have been identified as carcinogens or potential carcinogens by the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC) or OSHA, and comprise 0.1 percent or greater of the total mixture composition must also be listed and identified by both the chemical and common names. The table below provides a description of the key terms that will be encountered in this section of the MSDS.

Key Terms	Description
ACGIH	American Conference of Governmental Industrial Hygienists is a private organization of occupational safety and health professionals. ACGIH recommends occupational exposure limits for many toxic substances. ACGIH limits are often more stringent than OSHA limits, but are not legally enforceable.

OSHA	Occupational Safety and Health Administration is the federal agency which sets safety and health standards and regulates working conditions in most of the nation's workplaces.
CAS#	The Chemical Abstracts Service Registry Number is a number given to each chemical that identifies it as a specific chemical compound.
PEL	Permissible Exposure Limit is the amount of a chemical that a worker can legally be exposed. It can be an average exposure over time, or a one-time maximum exposure limit This limit is established by OSHA.
TLV	Threshold Limit Value is an exposure limit recommended by ACGIH. There are three types of ACGIH TLVs : **TLV-TWA -** The allowable Time-Weighted Average concentration for an eight-hour work day. **TLV-STEL -** The short-term Exposure Limit, or maximum average concentration, for a continuous 15 minute exposure period. **TLV-C -** The Ceiling Limit, or maximum concentration that should not be exceeded for any length of time.
ppm	Parts per million, or parts of the chemical per million parts of air.
mg / m^3	Milligrams per cubic meter. This is the weight of the chemical (usually a dust or vapor) in a cubic meter of air.

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

This section of the MSDS requires the inclusion of several important physical/chemical characteristics of the hazardous substance. Among these are the boiling point, melting point, specific gravity, vapor pressure, evaporation rate, vapor density and its solubility. The physical appearance and odor of the compound are also required information. This data is very important for both hazard recognition and emergency response analysis. The table below provides a description of the key terms that will be encountered in this section of the MSDS.

Key Terms	Description
Boiling Point	The boiling point of a chemical or chemical mixture is the temperature at which the vapor pressure of a liquid equals the atmospheric pressure. Therefore, it is the temperature at which the substance rapidly changes from a liquid to a gas. The lower the boiling point, the more quickly it will evaporate and emit potentially harmful vapors into the air.
Melting Point	The melting point is the temperature at which a solid will be in equilibrium with the liquid phase at atmospheric pressure. Therefore, at this temperature, a solid will begin to flow like a liquid.
Evaporation Rate	The time required to evaporate a certain volume of a liquid chemical compared to the time required to evaporate the same volume of a reference liquid (usually ethyl ether). In general the higher the evaporation rate and the lower the boiling point, the greater potential for release of hazardous vapors.
Solubility	The solubility of a substance in water should be reported as the percentage of product (by weight) that can be dissolved in distilled water at a specified temperature.
Specific Gravity	Specific gravity is the ratio of the density of a liquid, or solid, to the density of an equal volume of water, at a specified temperature. A substance with a specific gravity less than 1.0 will float in water, while a substance with a specific gravity greater than 1.0 will sink in water.
mmHg	Millimeters (mm) of the metal mercury (Hg) is a unit of measurement of pressure. For example, when used to define vapor pressure, it shows how likely a liquid is to vaporize. At sea level, the earth's atmosphere exerts 760 mm Hg of pressure.
Vapor Density	Vapor density is expressed as the density of the chemical vapor relative to that of air, which is assigned a vapor density of 1.0. Knowledge of the vapor density of a chemical product will allow the Operational Responder to determine whether the vapor will rise or sink in the ambient air. A chemical with a vapor density less than 1.0 will rise in air, while a chemical with a vapor density greater than 1.0 will tend to sink in air and "flow" along the ground, collecting in puddles.
Vapor Pressure	Vapor pressure refers to the pressure (expressed in mmHg) exerted by a chemical vapor in equilibrium with its liquid or solid phase at any given temperature. Information on vapor

	pressure can provide the Operational Responder with an indication of how easily a chemical can become airborne. The higher the vapor pressure, the more likely it is to have significant quantities of a chemical to vaporize in the air. High vapor pressure is greater than 10 mmHg. Low vapor pressure is less than 1 mm Hg.
Appearance and Odor	The appearance and odor of a chemical product may be identified by using the appropriate descriptive terminology on the MSDS. For example: viscous, colorless liquid with an aromatic odor.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

The MSDS should detail any unusual fire or explosion hazards that are inherent to the hazardous substance or dangers that may be initiated by a change in environmental conditions. The required information includes the flash-point, lower (LEL) and upper (UEL) explosion limit, recommended extinguishing media, special fire fighting procedures and unusual fire and explosion hazards. Some chemicals, for example, known as pyrophorics, can ignite spontaneously when they come in contact with air. No flame or spark is needed, which must be identified in this section of the MSDS. The table below provides a description of the key terms that will be encountered in this section of the MSDS.

Key Terms	Description
Combustible	Able to catch fire and burn. Moderate fire risk chemicals with a flash-point between 0^{o}F. and 200^{o}F. are considered combustible.
Flash-Point	The lowest temperature at which a liquid gives off enough flammable vapor to ignite (start to burn) if it comes in contact with a spark, flame or other ignition source. If the flash-point is less than 100^{o}F, a cigarette or static electricity could start a fire. Any time you have a chemical whose flash-point is less than the temperature of the area where it is used or stored, you have a potential fire hazard.
Ignition Temperature	Ignition temperature is the minimum temperature required to initiate self-sustained combustion of a material. This temperature may be the same as the flash point but is usually slightly higher.
Autoignition Temperature	The autoignition temperature is the lowest temperature at which a material will spontaneously ignite and burn. In this situation, heat is the only source of ignition. For most materials, the autoignition temperature tends to be high (several hundred degrees Celsius). However, some material, such as white phosphorus, will ignite at temperatures close to room temperature.
Flammability Limits	Flammability limits are the lowest and highest concentration (%) of vapors in air that will produce a flash fire when an ignition source is provided. It's unit of measurement is percent by volume in air. At a concentration too low to ignite, the mixture is too "lean" to burn. At a concentration too high to burn, the mixture is too "rich" to burn.
Flammable and Explosive	Flammable or explosive limits refer to the range of vapor concentrations in the air (percent by volume) that will burn or explode upon contact with an ignition source. The Lower Explosive Limit (LEL) is the lowest vapor concentration in the air which will ignite if provided a source of ignition. The Upper Explosive Limit (UEL) highest vapor concentration in the air which will ignite if provided with a source of ignition. The explosive range between the LEL and UEL indicates the degree of hazard. The greater the range, the greater the hazard. The LEL is an important factor to be considered when calculating the volume of air needed to ventilate an enclosed space to prevent fires and explosions.
Oxidizer	A chemical which gives off oxygen. Oxygen feeds fires, and can cause materials that are normally hard to burn, to burn more easily and at higher temperatures. Oxidizers should never be stored near flammable or combustible materials.
Extinguishing Media and Procedures	Extinguishing media specific to the particular chemical compound must be identified on the MSDS. Common extinguishing agents include water, foam, halon, carbon dioxide, dry chemicals and powders. Any special procedures that may be useful to fire fighters and other emergency response personnel (e.g., Do Not Use Water) should be reported in this section.

SECTION V - HEALTH HAZARD DATA

This section of the MSDS provides a variety of information to help the Operational Level Responder understand effects of chemical exposure. All chemicals can be handled safely and the human body can, and does, withstand low level exposures to toxic compounds. This section will provide an interpretation of "low level" exposures for the chemical compound. The MSDS format requires information on the chemical, substance's route of exposure, acute and chronic health hazards, carcinogenicity, signs and symptoms of exposure, medical conditions aggravated by exposure, and emergency and first aid procedures. Key terms associated with this section of the MSDS are listed in the following table:

Key Terms	Description
Routes of Exposure	Routes of chemical exposure include inhalation, ingestion, and absorption. It is important to identify any and all of the potential routes of entry for chemical exposure to Operational Responders.
Exposure Signs	Exposure signs describe how an overexposed individual is most commonly affected by the chemical. This should include any obvious physical indications as well as any subjective complaints that can be reasonably attributed to the exposure. Headaches, burns, rashes, difficult breathing, dizziness, and other illnesses are all signs of exposure.
Acute and Chronic Health Hazard	Acute and chronic health hazard data should include any health hazards for which there is statistically significant evidence, based on at least one positive study, conducted in accordance with scientific principles.
Acute Exposure and Effects	Acute effects occur immediately or in a short interval after exposure. They are typically sudden and severe (illness, irritation, and/or death) and are characterized by rapid absorption of the material. Acute effects are usually due to acute short term exposures.
Chronic Exposure and Effects	A chronic effect is one that develops slowly over a period of time, or which recurs frequently. Chronic exposure means a relatively low level of exposure which occurs over a relatively long period of time.
Aggravated Medical Conditions	Medical conditions that may be aggravated or worsened by exposure to a chemical must be identified on the MSDS. Such conditions may include high blood pressure, asthma and other chronic respiratory conditions, diabetes, allergies, skin disorders, and liver and kidney problems.
Emergency and First Aid Procedures	Emergency and first aid procedures must be specified on the MSDS for the purpose of providing information on the immediate steps to be taken in the event of a medical emergency until such time that a qualified medical professional can examine the victim.
Carcinogen	A chemical or physical agent capable of causing cancer.
LD-50	The dose of a chemical that will kill 50% of the test animals receiving it. The chemical may be given by mouth (oral), applied to the skin (dermal), or injected (parenteral). A given chemical will generally show different LD-50 values depending on the route of administration and the species of the test animal. This measures acute toxicity.

SECTION VI - REACTIVITY DATA

Reactivity data includes information on chemical stability, incompatibility, decomposition, conditions to avoid and hazardous polymerization. The MSDS should indicate whether the chemical is stable or unstable under reasonably conditions of storage, use, or misuse. It also should indicate whether or not the chemical will react readily with air or change its chemical structure when exposed to various combinations of temperature, pressure and light conditions. MSDS's should identify those conditions to be avoided when handling unstable chemicals. The table below provides a description of the terms used in the reactivity data section of the MSDS.

Key Terms	Description
Stability	A materials ability to remain unchanged. The substance is considered stable if it remains in the same form under reasonable conditions of storage or use. Conditions which may cause dangerous changes are stated on the MSDS. Examples are high temperatures or shock from dropping can cause violent reactions.
Reactivity	The ability of a substance to undergo a chemical change, either by reacting with other substances or by decomposing. Either change can create potentially a hazardous new chemical.
Incompatible Materials	Incompatible materials are chemicals or materials that can initiate a potentially dangerous reaction when brought into contact with an otherwise stable substance. The MSDS should identify any such incompatible materials and their attendant hazards.
Hazardous Decomposition	Hazardous decomposition is the breakdown of a chemical substance into simpler chemical products. If the decomposition products are hazardous, the MSDS should explain the conditions that may cause decomposition and name the by-products.
Hazardous Polymerization	Hazardous polymerization is a chemical reaction where molecular units of a chemical bond together, under certain conditions, to form a long chain called a polymer. Hazardous polymerization may occur when a reaction takes place at a rate that releases enough energy in the form of heat to cause a fire or explosion. Some chemicals can expand and burst their containers during a polymerization reaction. To help prevent hazardous polymerization, information about time period for which the chemical inhibitor will remain effective must be noted on the MSDS.

SECTION VII - SPILL, LEAK, AND DISPOSAL INFORMATION

Proper precautions for the safe handling and use of a chemical product must be indicated on the MSDS. This includes the steps to be taken in case the material is released or spilled, appropriate waste disposal methods, precautions to be taken in handling and storing the material, and any other safety precautions.

Response procedures for the cleanup of leaks, spills and other accidental chemical releases may include some or all of the following:

- Removing sources of ignition
- Avoiding the breathing of gases and vapors
- Providing additional ventilation
- Avoiding contact with liquids and solids
- Isolating contaminated areas
- Evacuating unauthorized personnel
- Diking materials for spills
- Knocking down vapors with water spray
- Applying absorbent material
- Sweeping and decontamination of areas

Appropriate waste disposal methods should also be specified on the MSDS for wastes that are created during spill cleanup and/or production operations. All waste should be disposed of in accordance with federal, state, and local regulations. The MSDS can never provide specific information about proper disposal due to the potential for a variety of waste stream contaminations and the variation in local and state requirements. All hazardous waste in the shipyard should be segregated and processed in the central accumulation area for proper waste determination and disposal.

SECTION VIII - CONTROL MEASURES AND SPECIAL PRECAUTIONS

This section of the MSDS requires information on the recommended control measures for reducing worker exposure to the hazardous substance. This includes engineering controls, personal protective equipment (PPE) and the appropriate work and hygienic practices. Some of the control measures that may be described are as follows:

Key Terms	Description
Ventilation and Engineering Controls	Engineering controls are the workers first line of defense against chemical exposures in the workplace. Ventilation systems, special enclosures, and other mechanical protection systems are all examples of engineering controls. Ventilation systems may be of the local exhaust type, which captures and removes contaminants at the source or of the general dilution type, which reduces contaminant levels by circulating fresh air through the work environment. The MSDS can indicate whether these or any other types of specially designed ventilation systems are of use in the workplace.
Personal Protective Equipment (PPE)	Personal protective equipment (PPE) usually includes gloves, safety glasses or goggles, face shields, aprons, boots, and respiratory equipment. Specific information should be given on the exact type of respiratory protection to be worn for every possible level of exposure. Protective gloves and eye glasses are available in a variety of materials. The MSDS should specify a certain type of eye protection or glove material to be used with any given chemical. Any other special protective clothing or equipment that is known to the manufacturer should be noted on the MSDS.
Other Hygiene Information	Any relevant hygienic and/or work practices that can be employed to protect employee health and safety should also be reported.

SECTION XI - LABELING

This section generally provides precautionary statements that also appear on the chemical container label. This is useful as it brings a primary source of information, the label, together with the technical information on the MSDS. It also provides other information for emergency responders, in the event of a spill, release, or contamination. Some of the other information is as follows:

- DOT shipping name
- United Nations Shipping Number
- Precautionary statements (Statement of Hazards) (Signal Word)
- NFPA Hazard Ratings
- HMIS Hazard Ratings

Session 9 Exercise #1.
Chemical Hazard Analysis Using An MSDS

Objectives of the Exercise
To provide the Operational Level Responder with an in-class, hands-on, exercise to enhance learning. Another objective involves the information exchange that will take place during the question and answer phase and group discussions.

The Chemical Hazard Analysis?

A chemical hazard analysis is focused on the chemical properties and what they mean to a potential emergency responder. The analysis includes completing the Chemical Hazard Analysis Sheet provided on the following page. Some of the issues addressed during chemical hazard analysis include:

- Emergency Response phone numbers
- Vapor density, appearance, odor and warning properties
- Flash-point, autoignition temperature, LEL, UEL
- Fire and explosion hazards and extinguishing media
- Exposure pathways and symptoms of exposure
- Chemical hazards (poison, corrosive, radioactive, reactive, etc.)

Hazardous Chemical Scenario

A 1 gallon drum of 1,1,1- trichloroethane (TCA, Trichlor) is dropped from a forklift and ruptures on the production floor. No one is injured and flow from the can has stopped at 50% loss. You cannot see the product label but a nearby person has an MSDS readily available. You are the first operational responder to analyze the MSDS and must make an initial chemical hazard analysis.

Workshop Assignment

Using the information provided on the MSDS for 1,1,1-trichloroethane, determine the hazards caused by this chemical. Review the MSDS and brainstorm ideas about the potential hazards inherent with the chemical. As a group, fill out the Hazardous Chemical Data Sheet and on the another page, rank your top 5 hazards from the highest to the lowest level of concern.

Work-Group Format

In groups of 4-6 persons, prepare a preliminary chemical hazard assessment by filling out the hazardous chemical data sheet and the hazard ranking sheet. Appoint a spokesman for the group to present the results of the analysis to the entire class.

Important Hazards to Think About
- Employee Health Hazards (PPE, respirators etc.)
- Environmental Hazards
- Fire and Explosion Hazards

Note: At this time, you are not analyzing the incident, you are only analyzing the hazards posed by the chemical.

Exercise #1 Hazardous Substance Data Sheet

Material Information

- Shipping name ________________ Emergency phone # ______________________
- Chemical name ________________ Manufacturers phone # ____________________
- DOT Hazard Class _____________ UN / NA ID# ___________________________

Physical Description

- Physical Form Solid _____ Liquid ______ Gas _______
- Color _______
- Odor ________
- Other ________
- Hazardous components Chemical Name CAS # % by wt.

____
____
____
____

Properties

- Specific Gravity ________ Density _______________
- Vapor Density _________ Boiling Point ___________
- Melting Point __________ Solubility in Water (Yes or No)

Toxic Human Hazards

- Inhalation hazard (Yes or No)
- Symptoms of inhalation exposure ____
- TLV/ TWA _________________ (ppm (mg/m3) LC-50 __________ (ppm/hr)
- Ingestion hazard (Yes or No) LD-50 __________ mg/kg
- Skin and eye contact hazard (Yes or No)
- Carcinogen (Yes or No) Teratogen (Yes or No) Mutagen (Yes or No)

Fire and Explosion Hazard

- Fire hazard (Yes or No) Toxic by products (Yes or No)
- Flash point _______________ Autoignition temp. _________
- UEL __________ (%) LEL __________ (%)

Reactivity, Corrosivity and Radioactivity

- Reactive (Yes or No)....................with water (Yes or No).............with air (Yes or No)
- Corrosive (Yes or No)......Acidic (pH) _______..............Basic (pH) _________
- Radioactive (Yes or No) Background, Alpha particle, Beta particles, Gamma radiation

Personal Protective Equipment Needed

- Respirator (Yes or No) What type? _______________
- Gloves (Yes or No) What type? _______________
- Glasses (Yes or No) What type? _______________
- Recommended Level ____________

Exercise #1 Hazard Analysis Ranking Using the MSDS

Group Member Names:

____
____
____
____
____
____

Hazardous Concerns:

#1 Hazard Risk ______________________________

Explain ______________________________
____
____

#2 Hazard Risk ______________________________

Explain ______________________________
____
____

#3 Hazard Risk ______________________________

Explain ______________________________
____
____

#4 Hazard Risk ______________________________

Explain ______________________________
____
____

#5 Hazard Risk ______________________________

Explain ______________________________
____
____

Instructor Answers and Discussion Notes:
There are really no right answers to this exercise. The purpose is to get the class using the MSDS and thinking like emergency responders.

Session 10.
Fire/Explosion and Confined Space Hazards

Session Objectives
To describe fire/explosion and confined space hazardous conditions in the shipyard and explain how those hazardous conditions become extremely dangerous when hazardous materials are involved.

Physical Injury During Hazardous Emergencies

Potential injuries in a hazardous substance emergency are real because workers can be exposed to a variety of hazards that may cause injury. It is important that the Operational Level Responder understands the potential risks. For example, an employee can be exposed to hazardous substances from head to toe, which could result in extreme damage to the eyes, face, skin, hands, legs and feet. The exact physical injuries and possible scenarios for hazardous substance emergencies are limitless. Caution must be exercised in all emergency situations, especially those that involve toxic substances. It must be understood that when chemical substances are involved in an emergency situation, the potential for physical injuries is significantly increased.

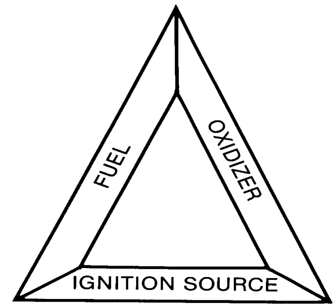
Fire/Explosion Hazards

There are many hazardous materials that will ignite and burn under certain conditions. These substances are dangerous and deserve special attention. There are three main terminologies that are used to define substances that burn:

Agency	Terminology For Flammable Substances
The Department of Transportation (DOT)	Two terms used to define materials that burn, *flammable and combustible*. A flammable liquid is a material exhibiting a flash point of less than 100°F. A combustible liquid is a material exhibiting a flash point of between 100°F and 200°F. In addition to flammable gases and liquids, there are also flammable solids. DOT defines flammable solids as solids, other than explosives, that can be ignited by friction, moisture, spontaneous chemical change or by retained heat from process or manufacture. Examples of flammable solids are magnesium metal, nitrocellulose, sodium metals, and many hydrides.
The Environmental Protection Agency (EPA)	Defines wastes that burn *as ignitable liquids* exhibiting a flash point of less than 140 ° F.
The National Fire Protection Association (NFPA)	Divides flammable materials with a flash point below 100°F as follows: Class IA - Liquids having a flash point below 73°F and a boiling point below 100°F. Class IB - Liquids having a flash point below 73°F and a boiling point above 100°F. Class IC - Liquids having a flash point between 73°F and 100°F regardless of the boiling point.

The Fire Triangle (What Makes a Fire?)

Combustion is a chemical reaction between two substances, one of which is usually oxygen, accompanied by the generation of light and heat. Fire hazards can be understood by examination of the fire triangle which illustrates the three circumstances that must be present for fire to occur. Once a fire has been initiated, heat, fuel, and oxygen are necessary to sustain a burning situation. The fire cannot continue if one of these components is removed.



There are two primary methods of preventing injury from fire or explosions. First is to prevent the fire or explosion from occurring and second is to maintain safe distance when they occur. People in an area with flammable vapor concentrations above the LEL must evacuate until the vapor concentration in the area is reduced to a safe level.

Ignition Sources

Smoking, and the carrying of lighters, matches, and other spark-producing devices, should be prohibited in areas where flammable liquids are stored, handled, used, dispensed, or transferred. A simple spark generated by a lit cigarette or static electricity can have sufficient energy to ignite flammable or explosive gases, vapors, or dusts. Static electricity can occur under many circumstances as follows:

- During mixing and agitation of materials
- While a liquid flows through a pipe or from an orifice into a tank
- During splash filling
- By the movement of pulley belts or vehicle tires

Bonding and Grounding

Static electricity can be prevented from causing a spark during flammable liquid transfer by bonding and grounding. Bonding is the linking of two containers by an electrical connection, usually a copper wire with clamps or "alligator" clips. Grounding eliminates a difference in electrical potential between a container and the earth. Grounding straps or wires must be connected to known grounds like gas or water pipes and grounded metal building framework. For bonding and grounding to be effective, both containers must be metal and at least one container must be grounded. It is important that clamps or clips make a good metal-to-metal contact.

Explosive Situations

Recognizing the potential for a hazardous situation is the first step towards prevention of fire or explosion. This includes using equipment to detect explosive or flammable atmospheres and using equipment (explosion-proof instruments and non-sparking bronze, brass, or aluminum tools) that will not ignite flammable gases or vapors.

Gases and vapors have limited concentration ranges in which they may burn or explode. Concentrations below this specific range of air to fuel, causes the mixture to become too "lean" to burn. Similarly, concentrations above this specific range of air to fuel, causes the mixture become too "rich" to burn.

This concept is only applied when oxygen (air) is present in a finite quantity. In a situation where oxygen is present in relatively unlimited quantity, such as outdoors or a well-ventilated area, this concept is not always applicable due to the wide range of air/fuel mixtures. The flammable range for

each type of hazardous substance is different and is defined by the Lower and Upper Explosive Limits (LEL and UEL).

Explosive ranges for some common compounds are given below:

Hazardous Substance	LEL	UEL
Acetone	2.6%	12.8%
Benzene	1.4%	8.0%
Gasoline	1.3%	6.0%

Values in % by volume in air (Sax, et al., 1987)

Portable Fire Extinguishers

If a fire starts, Operational Level Responders should leave the area unless they have been assigned fire fighting responsibilities. The incidents involving fire must be reported immediately! Property trained and equipped personnel will be dispatched to handle the situation. If the fire is small, properly trained workers may attempt to handle it by using the proper portable fire extinguisher. Portable fire extinguishers should be available in storage areas, around electrical equipment, and where flammable liquids are dispensed to prevent small fires from becoming large fires. The following portable fire extinguishers are classified by the National Fire Protection Association according to the types of burning materials they are designed to extinguish:

Class A Ordinary combustibles, such as wood, paper, textiles.
Class B Flammable liquids, such as oil, grease, paint.
Class C Fires involving electrical windings and equipment where safety requires the use of electrically non-conductive extinguishing media. This class is based on fire location and not burning material. Thus an extinguisher will not be marked only for Class C, but will be AC, BC, or ABC and should be selected accordingly.
Class D Combustible metals, such as magnesium, sodium, zinc, powdered aluminum.

The number used on the fire extinguisher indicates its extinguishing potential. For a Class A extinguisher, it is a relative rating. For example, a 2-A unit can be expected to extinguish approximately twice as much fire as a 1-A unit. For a Class B extinguisher, the number indicates the area, in square feet, of a deep layer flammable liquid fire expected to be extinguished by an unskilled operator. Class C and D units are not given a numeral rating.

Compressed Gas Hazards

Gas cylinders are prevalent at shipyards and pose significant hazards to employees, especially during a emergency incident. Gas cylinders are usually portable and contain gasses for welding and cutting. The gases are argon, oxygen, nitrogen, helium, carbon dioxide and others. Gas cylinders can weigh anywhere from 50 to 350 lb. and can be pressurized to over 2,000 psi. Proper handling and usage of compressed gas cylinders is important for controlling potentially hazardous situations. There are three main hazards associated with compressed gasses.

1) Explosion

Compress gas cylinders can explode like bombs. If the cylinder is in a fire or under other extreme heat conditions, the gas inside can expand to the point of cylinder rupture. If the cylinder explodes,

physical devastation will occur within hundreds of feet. This is an extreme danger and all responders should be made aware of gas cylinder location during an emergency response.

Acetylene under pressure can decompose with explosive force. It can explode with extreme violence if ignited. Copper or brass can form explosive compounds if they come in contact with acetylene. Similarly, greasy/oily fittings can cause oxygen cylinders under pressure to rapidly oxidize and result in an explosion. All fittings, shrouds and gauges should be made of the appropriate material and properly maintained.

2) Leaking Cylinders
A hazardous condition may exist if a compressed gas has a slow leak that goes unnoticed and is not repaired. These leaks can quickly disperse dangerous gases into a work area. This can result in flammable, toxic, corrosive or radioactive breathing environments. This is especially important in confined spaces or work areas with limited ventilation. The worker must know the warning properties of the gas and frequently check for leaks. Also, physical properties of the gas, such as vapor density, will describe if the gas will sink to the floor or rise to the ceiling, these properties can be important for emergency escape.

3) Extreme Compressed Gas Release
Gas cylinders can become airborne at a high speeds within moments. The cylinder can become a lethal projectile (i.e. a missile or bullet). This usually occurs when there is a sudden loss of pressure due to a broken stem valve or tank rupture. Compress gas cylinders such as SCUBA tanks have been known to fly several hundred feet, smash through brick walls, and cause various other property damage before coming to rest. Compress gas cylinder should be handled with extreme care and must be considered extremely dangerous in a hazardous substance emergency.

Practices for Safe Gasses Cylinder Handling and Usage

- The following practices are used to keep compressed gas cylinders “In Control”:
- Secure cylinders to walls with chains
- Store cylinders in cool, dry, well ventilated, locations out of direct sunlight
- Use cylinder transportation carts (Do not drag cylinder)
- Never transport cylinders inside closed vehicles
- Utilize valve protection cover when the cylinder is not in use
- Never drop, roll, or position the cylinder where the valve may be broken
- Treat a leaking cylinder as an a on-site reportable incident response
- Segregate empty (< 30 psi) and full cylinders
- Keep oxygen cylinders at least 20 feet from flammable gas cylinders
- Never smoke near flammable gases or oxygen
- Ground flammable gas containers
- Do not apply excessive force to remove a valve, protective cap, or other parts
- Always label cylinders properly
- Never use a wrench on hand valves

Confined Space Hazards

The shipbuilding and repair industry have instituted practices and procedures to protect employees from the hazards in confined spaces. Confined spaces are extremely dangerous because of the potential for lack of oxygen, presence of toxic gases and the potential for explosive conditions. In

general, a confined space is defined as an area that lacks a regular exchange of atmospheric breathable air. OSHA is in the process of revising present regulations concerning confined space entry. It is anticipated that these revisions will be published in the near future.

OSHA further defines a confined space as follows:
- Areas large enough that shipyard workers can enter and perform the required task
- Areas with limited or restricted means of Entry or Exit
- Areas that have poor ventilation
- Areas that are not designed for continuous occupancy by humans
- Areas that contain, or have the potential to contain, hazardous atmospheres
- Areas containing materials that may potentially engulf entrants
- Areas that have an internal configuration that may trap the entrant due to inwardly converging walls or floors that slope to a smaller space
- Areas where another serious hazard may exist
- Areas where the atmospheric condition is considered to be immediately dangerous to life and health (IDLH)

Examples of Confined Spaces
Confined spaces can be found in almost any kind of work place especially shipyards. The following is a listing of areas that should be treated as confined spaces:

Storage Tanks, Boilers and Furnaces	Bilge Tanks	Septic Tanks
Pumping Stations	Pipelines	Blocks
Sewers	Vats	Ship Holds
Sewage Digesters	Silos	Utility Vaults
Reaction Vessels	Trenches	Tubs/Vats
Pits	Compartments	

This list is not inclusive of all confined spaces that may be encountered in a shipyard. Other confined spaces can and do exist in the shipyard.

The Confined Space Entry Permit

Shipyards have a confined space entry permitting system to provide controlled access to confined spaces. Employees that enter and/or certify the confined spaces need to have specific training on confined space entry permitting. The entry permitting process will include, but not be limited to, the following:

- Procedures for safe entry and exit
- Hazard Evaluation for:
    - ◊ Oxygen content
    - ◊ Combustible gases and vapors
    - ◊ Toxic gases and vapors
- Space isolation and control
- Ventilation, lighting and PPE
- Entrant duties
- Attendant duties
- Supervisor duties
- Rescue and emergency procedures

The shipyard should have confined spaces marked with danger signs (or other equivalent means).

DANGER!
PERMIT REQUIRED CONFINED SPACE
DO NOT ENTER!

Having signs at every possible confined space is very difficult to accomplish in a shipyard where there are so many confined space opportunities. All employees must be aware of their location and never proceed unless they are sure that the space is not considered “confined”.

Operational Response Dangers Associated with Confined Spaces

The area in which the spill is occurs can become very hazardous for human health. The area may be ventilated for particular production operations, but when a spill or other hazardous condition occurs the area can become very toxic and/or explosive. An area where a hazardous substance is spilled area can become affected in the following ways:

- Explosive or extreme fire hazard if a spill should occur
- Infected with toxic gases and vapors
- Can have a reduction in oxygen (oxygen deficiency)
- Result in a immediately dangerous to life and health (IDLH) condition

Bottom Line:
All persons, workers and emergency respondents must be very aware of the dangers of hazardous substances in confined spaces. Never enter a confined space to save somebody who has collapsed until the level of risk is known. Fifty percent of all confined space deaths are people who were would be rescuers.

Session 11a.
Personal Protective Equipment (PPE) Awareness

Session Objectives
To describe the different types, materials and selection of Personal Protective Equipment (PPE) worn for hazardous emergency response and/or during daily operations.

PPE Can Protect The Whole Body (From Head-to-Toe)

Shipyards can be dangerous work places due to of the wide variety of hazards which are commonly present. The best way to protect yourself is by paying attention to what you are doing and taking the proper protective precautions. In some cases the proper precautions will include the use of Personal Protective Equipment (PPE). The best source of information on the selection, care, and use of personal protective equipment is available at the Shipyard Safety Department. PPE can provide protection for the worker, from head to toe, as displayed in the following table:

Area of Protection	Equipment
1. Head protection	Hard hats, helmets, hoods
2. Hearing protection	Ear plugs, ear muffs
3. Eye and face protection	Safety goggles, face shields, safety glasses
4. Respiratory protection	Air purifying respirators (APR), SCBA, particulate filters
5. Hand protection	A wide variety of work gloves
6. Body protection	Coveralls to total body encapsulation suits
7. Feet protection	Steel toed boots and chemical protective boots

1. Head Protection
Head protection is important, especially in an emergency situation. Hard hats are the most widely used and acceptable method of head protection. They offer protection where there is a hazard from striking one's head on low-hanging objects or from impact from falling objects. Hard hats are standard shipyard worker equipment. A hard-hat equipped with a chin or nape strap, is strongly recommended during most spill management situations.

2. Hearing (Ear) Protection
Ear protection plugs are standard issue in the shipyard because of the potential excessive noise levels in the construction areas. There are a variety of ear plugs available that are applicable to various noise levels, work duration, and comfort. A safety professional should be consulted when selecting hearing protection.

3. Eye and Face Protection
A. Safety Glasses - Industrial types of eye protection must be worn by all shipyard workers assigned to areas where there is exposure to flying particles, molten metal, airborne dust, or excessive radiant energy. Tempered safety glasses with side shields are the minimum requirement for shipyard work operations. These safety glasses provide minimal frontal and side protection.

B. Impact Goggles - These goggles are recommended for eye protection against projectiles weighing up to 0.1 ounce. Projectiles can be produced by the failure of various machine tools such as drill bits, grinding wheels, and similar equipment. Impact goggles do not protect against

chemical splashes and should not be worn when working with chemicals. They also do not protect against radiation.

C. Chemical Splash Goggles - These goggles are recommended for protection against chemical splashes and airborne mists, vapors, and fumes. Chemical splash goggles do not provide adequate protection where there is a risk of exposure to the entire face and neck area (for example; transfer of bulk acids or spills of hazardous liquids). Goggles are typically used in conjunction with a full face shield.

D. Welding Eye Protection Goggles and Hoods - Special protection is needed to protect against intense radiant energy, especially ultraviolet and infrared radiation, molten metal, slag, and flying particles. Welding goggles protect the workers eyes, while the welding hood is designed to protect the worker's face and neck area. In some circumstances welding may also require the use of a respirator.

E. Face-Shields - Face-shields are recommended for eye and face protection against splashing chemicals, flames, molten metals, hot liquids, cryogenics, and flying particles. Chemical splash goggles must be worn in conjunction with face-shields when handling and cleaning up strong corrosives or any bulk hazardous substances.

When Should Eye Protection Be Used In the Shipyard?

HAZARD	OPERATION	Eye and Face Protection
Harmful Radiation, Molten Metals	Welding, brazing	Welding Goggles and Hoods
Splash, Acid Burns, Harmful Vapors	Bulk Chemical Handling and Hazardous Substance Clean-up	Chemical Splash Goggles
Flying Particles	Chipping, Machining, Grinding (Light and Heavy), Spot Welding	Safety Glasses w/Side Shields Impact-Goggles Chemical Splash Goggles
Sparks, Harmful Radiation, Molten Metals	Electric Arc Welding and Cutting	Welding Goggles and Hood
Glare, Heat from Molten Metals Sparks and Splashes	Furnace Operations, and Molten Metals Operations	Welding Goggles and Hood Face Shield
Chemical Splash, Glass Breakage	Laboratory Situations (Photo Lab, Plating Operations, etc.	Chemical Splash Goggles Face Shield
Unknown Chemical Hazards	Hazardous Substance Emergency with Unknown Materials	Full Body Protective Shields

Note: While fighting a spill, Operational Level Responders will generally wear splash goggles, a full face-shield, and a full face mask respirator. This will be discussed further in session 11b.

4. Respiratory Protection

Respiratory protection is one of the most important types of PPE due to the potential for inhalation of toxic vapors and fumes in a hazardous emergency situation. There are several types of respiratory equipment used in the shipbuilding and repair industry. Respiratory protection ranges from dust masks to full Self Contained Breathing Apparatus (SCBA). In normal working situations, it is easy to determine what type of respiratory protection is needed, due to the ability to continuously monitor the worker for exposure. On the other hand, in an emergency situation, it can be difficult to determine what type of respiratory protection is needed. The following table lists some of the typical respiratory hazards and several types of applicable respirators.

Respiratory Protection	
Types of Hazards	Toxic Fumes Gaseous Chemicals Reaction By Products Dust

Types of Personal Respirators Available	Dust Protection Masks
	Air Purifying Respirators
	  Half Face Cartridge Type: Use Correct Cartridge
	  Full Face Cartridge Type: Use Correct Cartridge
	  Disposable Cartridge Type
	Self Contained Breathing Apparatus SCBA)
	Supplied Air Breathing Apparatus (SABA)

In general, SCBA is the best respiratory protection for managing chemical spills. However, cartridge type, or approved disposable units, may be acceptable if the concentration of oxygen in the air is over 19.5%, and if no chemical is present above the "Immediately Dangerous to Life and Health" (IDLH) level. Therefore, it may be necessary to perform air monitoring prior to entering a hazardous substance emergency situation. Do not rush into a emergency situation without respiratory protection, if you suspect potentially toxic fumes are present. The following sections describe the types of respirators in more detail:

Air Supplied Respirators - Deliver breathable air through a supply hose connected to the wearer's face piece. The air delivered must be free of contaminates or must be from a source located in clean air. The two types of commonly used air supplied respirators are the compressed air line and the self-contained breathing apparatus.

Air Line Respirators - Connected to a suitable compressed air source by a hose that the wearer trails behind. The air is delivered continuously or intermittently to the wearer's face mask. In addition, for atmospheres or environments categorized as immediately dangerous for life and health (IDLH) or for rescue operations, an airline respiratory system must be equipped with a 5-minute escape supply and be a pressure-demand type.

Self Contained Breathing Apparatus (SCBA) - Provides complete respiratory protection against toxic substances and oxygen deficiencies. The air supply apparatus is portable and is carried by the wearer. The airline is fastened from the portable tank, via a pressure regulator, to the face piece. SCBA’s are limited in use by the capacity of the air storage tank. Normally, air tanks have a 30-minute capacity, with a low-level alarm that signals when the tanks reach the remaining 5 minutes of air supply. This is the only system recommended for rescue operations or work areas classified as immediately dangerous to life and health (IDLH).

Air Purifying Respirators (APRs) - These respirators cleanse the contaminated atmosphere by passing the air through either a mechanical or chemical cartridge filter designed to remove specific contaminants. These devices are limited to those environments where there is sufficient oxygen to sustain life and the contamination levels are within the specified concentration limitation of the devices removal capacity.

5. Hand Protection - Selecting the Correct Glove

It is important to use the correct type of glove to protect hands from chemical or physical damage. Glove Compatibility Charts can provide a rough guide to the selection and use of gloves, although, workers should always seek the advice of a safety professional when making a determination of which glove to wear. Gloves are the best form of hand protection against sharp glass and metal,

chemical burns, thermal burns and chemical spills, splashes, and leaks. The table below illustrates the types of gloves available and their application in the shipyard environment:

GLOVE TYPE	HAZARD USED FOR
Buna-N	Epoxy Resins
Buna-N	Polychlorinated Biphenyls - PCB's
Butyl	Corrosive Chemicals, Oxidizers, Nitric Acid, Fluorine, Chlorine, Hydrogen Peroxide
Butyl	Solvents - DMSO, Isopropyl Alcohol
Ceramic Fiber	Thermal Protection
Kevlar	Cryogenics, High Temperatures Up to 1000^{o}F
Latex	Radioactive Materials
Leather	Materials Handling Wood Crates and Other Equipment
Leather, Ceramic Mesh, Steel Mesh	Abrasions, Cuts, and Sharp Objects
Neoprene	Acids Nitric, Hydrochloric, Sulfuric, Hydrofluoric
Neoprene	Soaps and Detergents
Neoprene	Solvents - Acetone MEK, MIBK
Neoprene Latex	Weak Acids and Weak Caustic Solutions (50% or less)
Nylon	Clean Room Abrasions
PVC	Alkalis
Viton Rubber	Solvents - Toluene, Xylene, Pyridine
Viton Rubber, PVA	Halogenated Solvents

Note: Stretch cotton gloves as underliners with all types of gloves whenever perspiration may be a problem.

6. Body Protection Equipment Properties of Common Protective Equipment

There is a wide variety of protective clothing available for the shipyard work environment. The type of clothing will be largely dependent on the chemicals being handled and the work at hand. The following table provides a general introduction to the types of body protective clothing available:

TYPE OF GARMENT	PROPERTIES
Shop Coat/ Apron	comfortable, inexpensive, disposable. low level of protection.
Tyvek	Available in a wide variety of styles & protection levels, disposable, economical. Poor mechanical resistance.
Tyvek Laminated With Saran	SARANEX is the material of choice for providing body protection when responding to many chemical spills. Saranex disposable clothing provides high levels of protection for chemicals such as PCB's, trichlorobenzenes, pentachlors, and cresols.
Tyvek Laminated With Polyethylene	PE-TYVEK is especially useful for body protection from water based spills, such as sodium dichromate, sulfuric acid, or sodium hydroxide.
Chemical Protective Suits (No Penetration Suits)	Available in self-contained or umbilical styles, highest level of protection possible; available in several materials. Expensive. Not for fire entry.

7. Foot Protection

Boots are designed to provide protection from many hazards the foot is subjected to including sharp objects, hazardous substances, bruises, and crushing. For hazardous chemicals, leather boots are not acceptable. Work boots, with protective coverings or chemical protective boots that also provide mechanical and slip protection are required. Boots that become contaminated must not be removed

from the work area unless decontaminated. Contamination on the sole of boots is a major source of spread of such contamination.

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Latex	Radioactive Materials
Leather	Materials Handling Wood Crates and Other Equipment
Leather, Ceramic Mesh, Steel Mesh	Abrasions, Cuts, and Sharp Objects
Neoprene	Acids Nitric, Hydrochloric, Sulfuric, Hydrofluoric
Neoprene	Soaps and Detergents
Neoprene	Solvents - Acetone MEK, MIBK
Neoprene Latex	Weak Acids and Weak Caustic Solutions (50% or less)
Nylon	Clean Room Abrasions
PVC	Alkalis
Viton Rubber	Solvents - Toluene, Xylene, Pyridine
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Note: Stretch cotton gloves as underliners with all types of gloves whenever perspiration may be a problem.

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7. Foot Protection

Boots are designed to provide protection from many hazards the foot is subjected to including sharp objects, hazardous substances, bruises, and crushing. For hazardous chemicals, leather boots are not acceptable. Work boots, with protective coverings or chemical protective boots that also provide mechanical and slip protection are required. Boots that become contaminated must not be removed

from the work area unless decontaminated. Contamination on the sole of boots is a major source of spread of such contamination.

Session 11b.
Personal Protective Equipment (PPE) Awareness

Session Objectives
To describe the different Levels of Personal Protective Equipment (PPE). This session also describes the variety of materials available for chemical and physical protection equipment and the way in which PPE can be rendered ineffective. The Operational Level Responder will gain a better understanding of their role in emergency response and the role of proper PPE.

Levels of Protection

Level of Protection describes the amount and type of protection offered by various types and combinations of protective equipment. The concept of Level of Protection is based on the fact that sometimes responders may need only minimum protection and other times they may need maximum protection. The EPA has established four levels of protection when working with hazardous materials and responding to hazardous material incidents. The four levels are identified as Levels A, B, C, and D. The level of protection required will depend on the type of work to be performed and working conditions. The worker should decide how much protection is needed (the level of protection) based on; 1) The type and concentration of the chemical in the workplace, or the emergency site, and its toxicity; and 2) The potential for exposure to hazardous substances in air, splashes of liquids, or other direct contact. The four levels are defined as follows:

LEVEL	DESCRIPTION
LEVEL A	The highest level, consists of a highly impermeable fully airtight encapsulating suit and all necessary support equipment, including Self-Contained Breathing Apparatus (SCBA) or supplied air breathing apparatus.
LEVEL B	The normal minimum for initial penetration into a hazardous spill area. Level B consists of SCBA, full chemical protective clothing, such as Saranex coveralls, and associated support equipment similar to Level A.
LEVEL C	This level is similar to Level B except that an air purifying respirator is used instead of supplied air. Level C is acceptable when known chemical exposures are less than the IDLH level and the proper respirator can be applied effectively.
LEVEL D	This level represents normal work clothing, such as shop coats and minimal splash protection. This is the general attire of Operational Level Responders.

The actual clothing and equipment will vary slightly from level to level with the main differentiation element for emergency response being focused on air quality and the type of respiratory protection required. The following table provides a itemized list of components for the four levels.

PPE Level	PPE Components of the Ensemble
Level A	- Positive pressure, self contained breathing apparatus (SCBA) * * - Pressure demand airline with escape bottle * * - Totally encapsulating chemical protective (TECP) suit * * - Inner coveralls and long underwear * - Inner and outer chemical resistant gloves and boots - Hard hat (depending on scope of work) - Cooling apparatus * - Radio communications *
Level B	- Positive pressure, self contained breathing apparatus (SCBA) * * - Pressure demand airline with escape bottle * *

	- Non-encapsulating chemical protective suit * * - Inner coveralls and long underwear * - Inner and outer chemical resistant gloves and boots - Hard hat (depending on scope of work) - Radio communications *
Level C	- Air purifying respirators with a full-face cartridge or canister capable of filtering out the contaminants associated with the tasks at hand - Non-encapsulating chemical protective suit - Coveralls and long underwear * - Inner and outer chemical resistant gloves - Boots (steel toe and chemical resistant with disposable boot covers) - Hard hat (depending on scope of work) - Radio communications *
Level D	- Normal work uniform - Dust respirator * - Coveralls - Work boots - Safety glasses and hard hat

* Optional
* * Supplied Air Respirators must be approved by the Mine Safety and Health Administration (MSHA) or the National Institute for Occupational Safety and Health (NIOSH)

One of the most important things to understand is when a worker should wear a certain level of protection. The table below briefly describes the requirement for each of the four levels:

	When Should Each Level Be Warn?:
Level A	Should be worn when the highest level of respiratory, skin, and eye protection is needed. Level A is needed when chemicals and concentrations are totally unknown and there is a potential for IDLH situations. Level A should also be worn in emergency situations where high concentration of toxic dusts, mists, fumes, gases and vapors are expected as well as exposures to unidentified chemicals and a high potential for splash or immersion exists. Similarly, Level A should be worn in confined, poorly ventilated areas that have not been approved for lower levels of protection.
Level B	Should be worn when the highest level of respiratory protection is needed, but skin protection is not as important. Level B is the minimum level of protection that should be worn to enter a site where the hazards have not yet been identified. For example, in emergency response situations where the type of chemical and concentration possibilities of contact are not known. A minimum of Level B should be worn until the hazards can be better identified during site characterization and analysis.
Level C	Should be worn when the criteria for using air purifying respirators (APR's) are met. For example, when the air contaminants have been identified and APR will be effective protection (not IDLH conditions). Also, Level C should be used when the airborne contaminants, liquid splashes, and other direct contact will adversely affect or be absorbed through exposed skin. Level C provides the same skin protection as Level B, but less respiratory protection.
Level D	Should be worn only as a work uniform when there are no suspected respiratory or skin hazards. Level D provides little skin protection and no respiratory protection. Therefore, Level D is only used when work functions do not include splashes, immersion or potential for unexpected inhalation of, or contract with, hazardous levels of any chemical.

Selection of PPE

The descriptive material in this section is designed to assist you in selecting and caring for various forms of personal protective equipment (PPE) . Anyone selecting PPE must be certain that the types selected are correct for the job. Users of PPE must be instructed on the following:

(1) it's use,
(2) it's limitations,
(3) proper fitting procedures,
(4) proper care, and maintenance.

When in doubt, check with your supervisor or a health and safety professional before using PPE or before doing a job that requires PPE.

Personal Protective Equipment (PPE) and Chemical Protective Clothing (CPC)

Shipyard workers and emergency response personnel involved with hazardous materials and wastes may be exposed to many types and forms of chemical substances. These substances and forms may include acids, alkalines, solvents, oxidizers, compressed gases, dusts, mists and fumes. The primary way that response personnel can protect themselves is by using the appropriate protective clothing and respirators.

There is an interface between protective equipment and the parts of the body to be protected. Throughout this manual Chemical Protective Clothing (CPC) and PPE are used as interchangeable ideas. Chemical protective the protective clothing acts as a barrier between the skin and chemicals that may damage the skin or get through the skin to damage other tissues and organs. In order to protect you from dangerous chemicals, protective clothing must be able to resist:

1. Penetration - Transport of chemicals through openings in clothing such as seams, zippers, etc.
2. Degradation - Chemical breakdown of the protective material due to contact with contaminants.
3. Permeation - Transport of chemicals through intact material. The clothing is not destroyed by the chemical, but the chemical can pass through the protective material to damage the skin and/or other organs.

1. Penetration: The term penetration is used to describe the ability of chemicals to penetrate through protective clothing seams, separations (i.e. where gloves, boots, and respirators meet the protective garment), stitch holes, zippers and button holes. When donning protective clothing these areas should always be inspected to determine if the garment meets the manufactures specification of design. A good way to inspect areas of potential penetration is to hold the garment up towards the light. If light shows through then the garment will be subject to penetration. In many cases, all areas, such as where gloves meet the sleeve or where respirators meet a coverall hood, are taped to reduce the potential for penetration. Many protective garments are equipped with flaps over zippers to reduce penetration. Another way of reducing penetration is to pull sleeve and ankle elastic bands over the gloves and boots. Do not tuck clothing legs inside boots, this will enable chemicals to be spilled or splashed directly into the boots.

2. Degradation: Degradation is the term used to describe a chemical attack on the construction materials of protective clothing. Degradation may cause the material to dissolve, swell, become brittle or crack. Degradation is observed visually as opposed to laboratory testing. Rates of permeation and penetration are increased as protective garments degrade. In simple terms degradation destroys the physical appearance of the garment. Degradation is usually a function of equipment age, amount of usage, maintenance practices, time in the sun, amount and type of chemical exposure amounts and overall equipment durability.

3. Permeation: Permeation is the term used to describe the ability of a chemical to penetrate a construction material of a protective garment. Some chemicals will permeate protective garments quickly while the same chemical may not have the ability to permeate a different material. When selecting protective clothing or other equipment, particularly respirators, health and safety personnel must determine the compatibility of protective garment construction material and the chemicals present in the work environment. Materials have various rates of permeation, which are determined by a laboratory permeation test. Many manufacturers provide permeation charts for their products to illustrate compatibility and rates of permeation. Other references concerning permeation and selection of PPE can be obtained from the American Conference of Governmental Industrial Hygienists (ACGIH) or the American Industrial Hygiene Association (AIHA).

Permeation Example:
Some typical data, collected by the Arthur D. Little Company on permeation of various chemicals through Saranex or PE-Tyvek are reported below:

CHEMICAL	TYPE OF TYVEK	PERMEATION DATA SUMMARY
PCB's	SARANEX-TYVEK	BREAKTHROUGH TIME > 60 MINUTES
1,2,4-TRICHLOROBENZENE	SARANEX-TYVEK	BREAKTHROUGH TIME >15 MINUTES
CRESOLS	SARANEX-TYVEK	NO DETECTABLE PERMEATION AFTER 2 HOURS OF EXPOSURE
SODIUM DICHROMATE	PE-TYVEK or SARANEX	NO DETECTABLE PERMEATION AFTER 8 HOURS OF EXPOSURE
SULFURIC ACID (UP TO 98%)	PE-TYVEK or SARANEX	NO DETECTABLE PERMEATION AFTER 8 HOURS OF EXPOSURE
SODIUM HYDROXIDE (40% SOLUTION)	PE-TYVEK or SARANEX	NO DETECTABLE PERMEATION AFTER 8 HOURS EXPOSURE

The role of PPE in Operational Level Response

The Operational Level Responder will generally be wearing Level D clothing unless a higher level is required for their work. The importance of proper PPE, especially respiratory protection, cannot be over emphasized. The Operational Responder is not to put themselves in danger. Their function is to perform an initial response for the purpose of stopping the release while protecting themselves, fellow employees, and the environment. The following items should always be kept in mind:

- Chemical exposure is dangerous
- Do not rush in, it could kill you
- Proper PPE is needed for a successful rescue
- If you need to don PPE, your too close! (Level D response)

Session 12.
Recognizing and Identifying Hazardous Substances In An Emergency Situation

Session Objectives
To provide instruction on how to recognize and identify hazardous substances in an emergency situation and understand that responder safety is essential.

Introduction

Recognition and identification of hazardous materials is a key element for an organized, safe and effective emergency incident response. Recognition and identification of hazardous substances in an emergency is the Operational Level Responder's first line of defense. A situation that can cause serious harm is inevitable if an emergency responder does not recognize that hazardous materials are involved. After recognizing and identifying a hazardous material and the associated hazardous characteristics, the responders can initiate the appropriate response. The following list describes several key hazardous material recognition clues:

- Shipyard hazardous materials and waste locations (i.e. Plating shop, garage, machine shop, or haz-waste areas)
- Container shapes and substance forms (i.e. 55 gallon drums, plastic jugs, liquids, solids, etc.)
- Markings & Colors (i.e. Package/label markings or colors)
- NFPA and DOT Placards & Labels (i.e. Orange placard = Explosive)
- Shipping Papers (if material is in transport)
- MSDS (e.g. Hazcom MSDS books located nearby)
- Senses (i.e. Sight, hearing and smell - last resort)
- People can be running from the scene or people could be collapsed in the area
- Other Clues (i.e. responsible party, witness, response plan, etc.)

Remember to always assume that there are hazardous materials present and look for clues or warning signs until you confirm the absence of hazardous materials.

Shipyard Hazardous Locations

This applies chiefly to shipyard areas and buildings that may contain hazardous materials and/or wastes. These area could include manufacturing, metal processing, painting operations, hazardous materials storage areas, maintenance and machine shops. While many locations are obvious repositories of hazardous materials, others locations are more subtle. For example, there can also be hazardous materials in the photo-labs, engineering departments, and other support areas that may not be intuitively associated with hazardous materials. These areas should be clearly marked and should be included in the shipyard hazardous materials response plan.

Hazardous Substance Forms and Associate Container Types

Operational Level Responders must have a good understanding of the variety of shipyard hazardous substance forms and associated containers. This will enable the Operational Level Responder to determine if a hazardous substance is involved with the incident and provide a better understanding of the hazardous condition. A proper chemical recognition and identification will provide valuable information about attending to the chemical exposure and spill clean-up.

A hazardous substance may take the form of a solid, liquid or gas. As a substance is cooled or heated it may change from one form to the other. The hotter the workplace environment (or the more heat used in the process), more a liquid or solid will evaporate or otherwise give off harmful fumes and vapors. The following table illustrates various shipyard substances, their forms and potential container types:

Substance Forms	Shipyard Hazardous Substance Example	Example Potable Container Types
1. Solids	Cyanide, Grit, Paint Solids, Production Dust, Fiberglass, Welding Fumes	Hazardous solid substances generally are packaged in high performance bags, boxes, and cans/jars (plastic and metal).
2. Liquids	Paints, Solvents, Acids	Hazardous liquid substances generally are packaged in metal cans (1 to 5 gallons), 55 gallon drums (plastic and metal), and a variety of plastic, metal or glass jars.
3. Vapors & Gases	Welding Gasses, Welding Fumes, Aerosols	Hazardous gases are packaged in high performance pressurized cylinders from 5 to 500 pounds in weight.

Note: All types of materials, especially hazardous gasses and liquids can be stored in large permanent tanks.

1. Solids: Solids most dangerous to your health are dusts, fibers, and fumes. These types of solids are so small that they can be inhaled directly into the lungs where they may damage the lungs or pass into the bloodstream to harm other parts of the body.

Solid Type	
Dusts	Solid particles made by handling, crushing, or grinding materials such as rock, metal, coal, wood, or grain. Any process that creates dusts in the air should be considered hazardous until industrial hygiene testing proves it safe.
Fibers	Dust particles whose shape is long and narrow rather than rounded. If the length is three or more times the width of a particle, it is called a fiber. The most well known fiber in the industry is the *asbestos* fiber.
Fumes	Tiny solid particles produced by heating metals. Fumes are produced mainly in industrial high-heat operations, like welding, melting and furnace-work. Fumes are often mixed with hazardous gases, like ozone and nitrogen oxides, which are taken in by the lungs at the same time. Aerosol is the general term for any airborne particle, whether solid or liquid.

Note: Particle size is important in determining how harmful a particle is to your health. Particles range in size from 0.1 to 25 micrometers. Only particles less than five micrometers stay suspended in the air long enough to be inhaled. These fine particles cannot be seen without a microscope, but they are the most dangerous to your health because they can penetrate deep into your lungs.

2. Liquids: Hazardous liquid containers are used, stored and transported throughout the shipyard and pose a continuous threat of spillage and personal contamination. Liquids can splash or spill onto people and into the environment. Also, liquid hazardous substances can enter the body through all three exposure routes (ingestion, dermal, and inhalation). Liquids are used in large quantities at shipyards and pose a significant threat to human exposure as well as potential environmental releases to lakes, rivers, and bays.

3. Vapors & Gases: A vapor is the technical name for the gaseous form of a liquid. Vapors are generated from the surface of a liquid, just as water vapor always exists over liquid water. The closer a liquid is to its boiling point, the more it vaporizes. Liquids with boiling points just above room temperature vaporize readily, and are called volatile.

A gas is a fluid that expands quickly to fill the space that contains the gas. In other words, gasses will expand and seek to take up more area and become less concentrated. Many gases are highly flammable and very reactive, both chemically, and within the body. Gases for welding operations are contained in pressurized cylinders throughout the shipyard. These containers pose significant risk to human safety and to the environment during an emergency incident. If a compressed gas cylinder is in the immediate area to an incident, it adds an extra element of risk. Compressed gas cylinders have the potential of rapidly releasing the gas, which can project the heavy cylinder like a torpedo.

Hazardous Container Labels

All containers of hazardous chemicals that enter the shipyard must have a label. The label is the primary source of information regarding the hazards of a chemical. The first time a person handles a chemical, and whenever a significant period has passed since the information has been reviewed, the detailed precautionary information on the label should be reexamined. This information will include:

- **What The Hazards Are**
- **How To Avoid The Hazards**
- **How To Recognize Exposure**
- **What To Do In Case of Exposure**
- **How To Handle Spills and Accidents**

In the event of a spill or personal chemical exposure, it is imperative that the Operational Level Responder know the type and nature of the chemical involved. A proper chemical label will provide the necessary information to clean-up the spill or attend to the chemical exposure (i.e., wash eyes with water).

The Signal Word and Statement of the Hazard

The "Signal Word" alerts the person using the chemical to the level of the hazard associated with using the material. The choice of signal word depends on the nature of the hazardous substance, its concentration, and the degree of harm that exposure will cause. The Operational Level Responder must understand the "Signal Word" because it will be the most visible information on the chemical container label. When used to identify FIRE HAZARDS, the Signal Word has the following meanings:

Signal Word! Example	STATEMENT OF HAZARD	FLAMMABILITY LEVEL
DANGER! Gasoline	EXTREMELY FLAMMABLE	Flashpoint below 20^oF
WARNING! Toluene	FLAMMABLE	Flashpoint between 20^oF and 100^oF
CAUTION! Diesel Fuel	COMBUSTIBLE	Flashpoint between 100^oF and 200^oF

Persons identifying hazardous substances should always identify the **"Signal Word"** and **the "STATEMENT OF THE HAZARD".**

TYPICAL STATEMENTS OF HAZARD	
- MAY BE FATAL IF SWALLOWED - HARMFUL IF SWALLOWED	- CAUSES IRRITATION - CAUSES SKIN ALLERGIC REACTION

- MAY BE FATAL IF INHALED - MAY BE FATAL IF ABSORBED THROUGH SKIN - HARMFUL IF INHALED - MAY CAUSE ALLERGIC RESPIRATORY REACTION - CAUSES SEVERE BURNS - EXTREMELY FLAMMABLE	- CONTACT WITH ACID LIBERATES POISONOUS GAS - HIGHLY VOLATILE - CONTACT WITH WATER MAY CAUSE FLASH FIRE - POWERFUL OXIDIZER - MAY FORM EXPLOSIVE PEROXIDES

Types of Container Labels

There are four main types of container labeling systems used to identify potentially hazardous substances and the specific hazards they present.

1) American National Standards Institute (ANSI)

The ANSI label mainly uses words to communicate information. It lists the physical and health hazards, including the target organ effects. The level of hazard and Signal Word is printed on the upper left side of the label. The signal words and their meaning are:

- ***DANGER*** Serious hazard
- ***WARNING*** Less hazardous but still severe
- ***CAUTION*** Moderate hazard but still of concern

2) Department of Transportation (DOT)

DOT labels are diamond shaped and are usually present on containers and vehicles for transportation purposes. Colors and symbols that are used to represent the hazards are presented in the following table:

	HAZARD	COLOR (SYMBOL)
1	EXPLOSIVE	ORANGE (BURSTING BALL)
2	GASES	GREEN (BOTTLE)
3	FLAMMABLE LIQUID	RED (FLAME)
3	FLAMMABLE SOLID	RED STRIPED (FLAME)
4	NON-FLAMMABLE GAS	GREEN
5	OXIDIZER	YELLOW (FLAMING “O”)
6	POISON OR TOXIC	WHITE (SKULL AND CROSSBONES)
7	RADIOACTIVE	YELLOW & WHITE (RADIOACTIVE SYMBOL)
8	CORROSIVE	BLACK & WHITE (TEST TUBE)
9	MISC. HAZ-MATS	BLACK & WHITE (VERTICAL STRIPES)

3) National Fire Prevention Association (NFPA)

The NFPA labeling system is intended to convey hazard information concerning chemical products to fire fighters and other emergency responders. The NFPA uses a four-color coded diamond symbol to communicate the hazard level. The numbers represent the degree of hazard. The hazards are rated on a scale of zero to four. Zero or one means no hazard or minimal hazard and a four represents a high or severe hazard.

Diagram - NFPA Label

4) Hazardous Material Information System (HMIS)

The HMIS labeling system provides the degree of hazard of a chemical under normal usage conditions. The HMIS label lists the chemical name, health hazard, flammability, reactivity, and

personal protective equipment. Similar to the NFPA labeling method, a number, from zero to four, represents the degree or severity for the hazard. Letters illustrate the recommended personal protective equipment.

Diagram - HMIS label

<u>5) Military System</u>

The military system, like the NFPA system, is specifically designed to address fixed locations. It is generally used on military installations, and not in transportation. The emergency responder should be familiar with the details of this system if they have a Department of Defense installation within their jurisdiction.

When Hazardous Materials Are Recognized, First Operational Thought is SAFETY

Once a hazardous material or waste is recognized from identifying the label and container, the Operational Level Responder must always think safety! It is important to think safety first, last and always. When hazardous materials are present in an emergency situation, the risk to human health and safety is increased significantly. Once a hazardous substance has been identified, the Operational Level Responder must use a “go slow approach”. A quick and unplanned response can kill or injure the Operational Responder and others in the area. Always maintain a "Positive Safety Attitude”. Negative safety attitude responders think that safety precautions are overkill, which frequently results in injury and even death for the responder and others.

Maintain a Positive Safety Attitude

- Use recognized safety procedures via vigilance and discipline
- Develop awareness of possible secondary and tertiary hazards
- Treat all Haz Mat events with respect and anticipate problems
- Cross reference 3 or more sources before action planning
- Ensure back-up plans are in place for failure of safety devices
- Maintain a "Mental Safe Approach Tactic" while on-scene
- Always keep your distance until the Hazards have been fully identified (Upwind, Upgrade, Upstream)

Remember the Six Ways Hazardous Material Can Kill You!

1. Toxicity	2. Radioactivity
3. Asphyxiation	4. Explosion
5. Combustibility/Flammability	6. Corrosion

Session 13.
The North American Emergency Response Guidebook (NAERG96) and Other Information Sources

Session Objectives

To explain the Department of Transportation's (DOT's) 1996 Emergency Response Guidebook (ERG) purpose and use. Also, to explain CANUTEC and Mexico response affiliations.

Background and Purpose of the North American Emergency Response Guidebook (NAERG96)

The 1996 North American Emergency Response Guidebook (NAERG96) was developed jointly by Transport Canada (TC), the U.S. Department of Transportation (DOT), and the Secretariat of Communications and Transportation of Mexico (SCT) for use by fire fighters, police, workers, and other emergency services personnel who may be the first to arrive at the scene of a incident involving dangerous goods (hazardous substances). It is primarily a guide to aid first responders in quickly identifying the specific or generic hazards of the materials involved in the incident with the priority of protecting themselves and the general public, during an initial response.

This guidebook will assist Operational Level Responders in making initial decisions upon arriving at the scene of a hazardous substances incident. It should not be considered a substitute for emergency response training, knowledge or sound judgment. The NAERG96 does not address all possible circumstances that may be associated with a hazardous substance incident. It is primarily designed for use at a hazardous substances incident occurring on a highway or railroad. Be mindful that there may be limited value in its application at fixed facility locations.

The NAERG96 is a basic safety tool for identification and response information that recognized as good practice standards for Operational Level Response during initial actions. The NAERG96 has five types of page border colors and the following basic organization:

1) **White -** Basic information and instructions (Placard Table)
2) **Yellow -** Four digit number, guide number and material name
3) **Blue -** Material name, guide number and four digit number
4) **Orange -** Guide number pages
5) **Green -** Table of isolation and protective actions

The Guide Number Pages (Orange)

Each orange-bordered, numbered guide, provides essential guidance in a form which is designed for first responders with limited hazardous substances training. A numbered guide is assigned to each material listed in the indexes. The order in which the guides are presented, nor the guide number itself, is of any significance. Since many materials represent similar types of hazards that call for similar initial emergency response actions, only a limited number of guides are required. The orange-bordered guides are not applicable when materials of different classes and/or divisions are involved in an incident and are intermingled. Incidents involving more than one class of material require the incident commander to obtain informed advice as soon as the scope of the incident can be determined. Materials involved in an incident may by themselves, be non-hazardous; however, a combination of several materials or the involvement of a single material in a fire, may still produce serious health, fire or explosion hazards.

First responders at the scene of a hazardous substances incident, should seek additional specific information about the hazardous substance in question as soon as possible. The information received by contacting the appropriate emergency response agency, the emergency response number on the shipping document, may be more specific and accurate than the response NAERG96 information. The following itemized list provides information sources that may be vital in identifying a hazardous substance:

1. MSDS (e.g. Material Safety Data Sheets for a chemical)
2. Placards and labels (e.g. colors and symbols)
3. Shipping papers (e.g. Bill of Lading, Way Bill, Etc.)
4. Reference guides (e.g. North American Emergency Response Guidebook 1996)
5. Technical information centers (e.g. CHEMTREC)
6. NFPA 704 Labeling System
7. Computer data bases (e.g. CAMEO and HIT); etc.
8. UN or NA #, (United Nations or North American 4 digit #)
9. Chemical CAS # (Chemical Abstract Services #)

BECOME FAMILIAR WITH THE NAERG96 BEFORE USING IT DURING AN EMERGENCY!

HOW TO USE THE GUIDES EFFECTIVELY

In the U.S., according to the requirements of OSHA and EPA, first responders must be trained regarding the use of the NAERG96. The titles of the orange guide pages identify the general hazards of the hazardous substances covered. The process for using the NAERG96 is presented below:

1.) Identify the Material

Find one of the following
- The 4-digit ID # on a placard or orange panel
- The 4-digit ID # on a shipping paper or MSDS
- The Name of the material on a shipping paper, MSDS, or the package If an ID# or the material name cannot be identified and the placard can be seen, use the hazard table to determine the Guide #

2) Look up the Material s 3 digit Guide

- The ID # index (Yellow Bordered Pages)
- The Name of the Material Index (Blue Bordered Pages)

Note: The letter "P" following the guide number in the yellow-bordered and blue-bordered pages identifies those materials which present a polymerization hazard under certain conditions; for example, Acrolein, inhibited, Guide 131 P. Also, If the material is Highlighted in either index, look-up the material in the Table Of Initial Isolation and Protection Action Distances. (Green Bordered Pages)

3) Turn to the Guide Pages (Orange Bordered Pages) and Read Carefully!

Each guide is divided into three main sections:

Section 1 Potential Hazards - Section 1 describes potential hazards that the material may display in terms of fire/explosion and health effects upon exposure. The emergency responder should consult this section first since it indicates in brief form the dangers the material may

present. This allows the responder to make decisions regarding the protection of the emergency response team as well as the surrounding population.

Section 2 Public Safety - The second section outlines suggested public safety measures based on the situation at hand. It provides general information regarding immediate isolation of the incident site, the recommended type of protective clothing and respiratory protection. Suggested evacuation distances are listed for small and large spills and for fire situations.

Section 3 Emergency Response - The third section covers emergency response actions and first aid. It outlines special precautions for incidents which involve fire, spill or chemical exposure. Several recommendations are listed under each part which will further assist in the decision making process.

The information on first aid is general guidance prior to seeking medical care. It is difficult to be specific about the kind of medical assistance that should be sought. Factors for consideration will include, 1) the extent of the exposure, 2) the material involved, 3) the nature and severity of the injuries, and 4) the proximity to emergency and medical services. When human exposure has occurred, immediate efforts should be made to remove all contaminated clothing and shoes and to obtain medical assistance in evaluating the injuries and need for hospitalization.

Note: NAERG96 incorporates hazardous substances lists from the most recent United Nations Recommendations as well as from other international and national regulations. Explosives are not listed individually by either proper shipping name or ID Number. They do, however, appear under the general heading "Explosives" on the first page of the ID Number index (yellow-bordered pages) and alphabetically in the Name of Material index (blue-bordered pages).

Hazard Classification System

The hazard class of hazardous substances is indicated either by its class (or division) number or name. For a placard corresponding to the primary hazard class of a material, the hazard class or division number must be displayed in the lower comer of the placard. However, no hazard class or division number may be displayed on a placard representing the subsidiary hazard of a material. The hazard class or division number must appear on the shipping document after each shipping name.

Hazard Classes

The “hazard class” of any particular hazardous material is indicated either by its class or division number and its class name. The hazard class or division is required on the shipping paper and it is also used to determines placarding, marking and other labeling requirements. The following table describes the hazard classes, their placard color and the NAERG96 Guide #.

Class/Division	Division Name	Placard Color	Guide #
1.1	Explosives (mass explosion hazard)	Orange	112
1.2	Explosives (projection hazard)	Orange	112
1.3	Explosives (predominantly a fire hazard)	Orange	112
1.4	Explosives (no significant blast hazard)	Orange	114
1.5	Insensitive Explosives; Blasting Agents	Orange	112
2.1	Flammable Gas	Red	118
2.2	Non-Flammable Compressed Gas	Green	121
2.3	Poisonous Gas	White	123

3.0	Flammable & Combustible Liquid	Red	127 / 128
4.1	Flammable Solid	Red/White Stripes	134
4.2	Spontaneously Combustible Material	White/Red Half/Half	136
4.3	Dangerous When Wet Material	Blue	139
5.1	Oxidizer	Yellow	143
5.2	Organic Peroxide	Yellow	148
6.1	Poisonous Materials	White	153
6.2	Infectious Substance (Etiologic Agent)	White	158
7.0	Radioactive Material	White/Yellow	163
8.0	Corrosive Material	White/Black	153
9.0	Miscellaneous Hazardous Materials	White/Black Striped	171

NAERG96 Spill Notification

The NAERG96 covers spill control and reporting for Canada, United States and Mexico. Information about each of the reporting and information phone numbers is descried below:

CANADA:

CANUTEC is the **Canadian Transport Emergency Center** operated by the Transport Dangerous Goods Directorate of Transport Canada. **CANUTEC** provides a national bilingual (French and English) advisory service and is staffed by professional chemists experienced and trained in interpreting technical information and providing emergency response advice. Phone number are as follows: In an emergency 613-996-6666 (24 hours) and non-emergency 613-992-4624 (24 hours).

UNITED STATES:

CHEMTREC and CHEM-TEL, INC. maintain a current list of state and Federal radiation authorities who provide information and technical assistance on handling incidents involving radioactive materials The emergency response information services (CHEMTREC and CHEM-TEL) have requested to be listed as providers and have agreed to provide emergency response information to all callers. Calling the emergency response telephone number, CHEMTREC or CHEM-TEL, INC., does not constitute compliance with regulatory requirements to call the NRC. Their phone numbers are:

- **CHEMTREC,** a service of the Chemical Manufacturers Association, can be reached as follows: CALL CHEMTREC (24 hours) 1-800-424-9300 (Toll-free in the U.S. and Canada)
- **CHEM-TEL, INC.**, an emergency response communication service, can be reached as follows: CALL CHEM-TEL, INC. (24 hours) 1-800-255-3924 (Toll-free in the U.S. and Canada)

NATIONAL RESPONSE CENTER (NRC) - The NRC, which is operated by the U.S. Coast Guard, receives reports required when dangerous goods and hazardous substances are spilled. After receiving notification of an incident, the NRC will immediately notify the appropriate Federal On-Scene Coordinator and concerned Federal agencies. Federal law requires that anyone who releases into the environment a reportable quantity of a hazardous substance (including oil when water is, or may be affected) or a material identified as a marine pollutant, must immediately notify the NRC. When in doubt as to whether the amount released equals the required reporting levels for these materials, the NRC should be notified. NRC (24 hours) 1-800-424-8802 (Toll-free)

MILITARY SHIPMENTS - For assistance at incidents involving materials being shipped by, for, or to the Department of Defense (DOD), call one of the following numbers (24 hours): 703-697-0218 (call collect) (U.S. Army Operations Center) for incidents involving explosives and ammunition. 1-800-

851-8061 (toll free) (Defense Logistics Agency) for incidents involving dangerous goods other than explosives and ammunition. The above numbers are for emergencies only.

MEXICO:

- **SETIQ** (Emergency Transportation System for the Chemical Industry), a service of the National Association of Chemical Industries (ANIQ), can be reached as follows:
Call SETIQ (24 hours) 91-800-00-214 Mexican Republic, 575-08389 575-0842 or 559-1588
- **CECOM,** the National Center for Communications of the Civil Protection Agency, can be reached as follows: **CALL CECOM (24 hours)** 91-800-00-413 in the Mexican Republic, 550-1496, 550-1552, 550-1485, or 550-4885 for Mexico City and the Metropolitan Area

Other Sources of Information about Chemicals and Emergency Response

There are many sources of information and response organizations that can provide technical data and physical assistance during hazardous materials incidents. These information sources provide technical input regarding both hazards associated with a spill and methods to mitigate the problem. The different levels of information that may be required include site information, meteorology, physical/chemical properties of the hazard, applicable treatment methods, and the available cleanup resources. This information can be provided by various agencies, reference books, and manuals.

When using sources of information, it is advisable to cross-check references. Always obtain concurring data from at least two sources and try to use the most current edition of any reference, especially when searching for hygienic standards or toxicological data.

Source of Information	Description
1. OHMTADS: Oil and Hazardous Materials Technical Assistance Data System, developed by EPA. Access through EPA Regional offices.	OHMTADS is a computerized data retrieval system available in the form of a printout, manuals, or microfiche. For each of more than 1,000 types of oil and hazardous substances, there are 126 possible information segments on, for example, toxicity and associated hazards, personnel safety precautions, cleanup and disposal methods, materials handling, and fire fighting. However, not all information is available for all materials.
2. *Documentation of the Threshold Limit Values (TLV),* Fifth Edition (1986) ACGIH Publications Office, 6500 Glenway Ave., Building D-5, Cincinnati: Ohio 45221	This reference includes pertinent scientific information regarding each substance, with references to literature sources used to determine each TLV. Each documentation also defines the type of toxic response for which the limit is used. This book should be consulted for a better understanding of TLV'S.
3. NIOSH/OSHA Pocket Guide to Chemical Hazards, U.S. Government Printing Office, Washington, D.C. 20402	Information in this pocket guide comes from the *NIOSH/OSHA Occupational Health Guidelines.* Presented in a tabular format, it is a reference for industrial hygiene and medical surveillance practices. Included are chemical names and synonyms, permissible exposure limits, chemical and physical properties, signs and symptoms of overexposure, environmental and medical monitoring procedures, recommended respiratory and personal protective equipment, and procedures for treatment.
4. NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards, U.S. Government Printing Office, Washington, D.C. 20402	This three-volume document provides technical data for most of the substances listed in the *NIOSH/OSHA Pocket Guide.* The information is much more detailed and is designed primarily for use by industrial hygienists and medical surveillance personnel. In addition to the information found in the *Pocket Guide, Occupational Health Guidelines*

	includes recommended medical surveillance practices, air monitoring and measurement procedures, personnel sanitation, and spill and disposal techniques.
5. *Fire Prevention Guide on Hazardous Materials* (1984), National Fire Protection Association (NFPA), Quincy, Massachusetts	The NFPA has combined five manuals into one comprehensive guide on hazardous materials, which discusses: 1. Flash point of oils, together with more than 8,800 trade name chemicals, their flash points, manufacturers, and principal uses. The flammability hazard can be determined from this information. 2. Fire hazards of 1,300 flammable liquids, gases, and solids are listed in alphabetical order with appropriate fire fighting information. Various properties listed include flash point, specific gravity, water solubility, hazard identification, and boiling point. 3. Toxicity data on 416 chemicals. 4. Hazardous reactions of over 3,550 chemicals. Reactions may involve two or more chemicals and cause fires, explosions, or other problems. A chemical is listed, followed by those chemicals which can cause a hazardous reaction. 5. Recommended system for identification of fire hazards of materials. The NFPA labeling system is described in detail, with a careful explanation of the ratings.
6. *The Merck Index,* Tenth Edition (1 983), Merck and Co., Rahway, New Jersey 07065	*The Merck Index* is a comprehensive, interdisciplinary encyclopedia of chemicals, drugs, and biological substances. It describes 9,856 chemicals in a structured format. An extensive index and cross-index make the manual easy to use. It is designed to serve a variety of purposes. For response personnel, it provides information on physical and chemical properties of materials and their toxicity.
7. *Dangerous Properties of Industrial Materials,* Sixth Edition(1984),N. Irving Sax, Van Nostrand Reinhold Company, 135 W. 50th Street, New York, New York 10020	This book provides a single source of concise information on the hazards of nearly 13,000 common industrial and laboratory materials. Descriptive information and technical data are given in the three sections of the book. The main section, "General Information," is designed to expedite retrieval of hazard information. The three sections are: 1. General Information: synonyms, description, formula, physical constants 2. Hazard Analysis: toxicity, fire hazard, explosive hazard 3. Countermeasures: handling, storage, shipping, first aid, fire fighting, personnel protection This book is not intended for use on site. It can be useful later, however, to verify hazards associated with the emergency.
8. *The Condensed Chemical Dictionary,* Tenth Edition (1981), Gessner G. Hawley, Van Nostrand Reinhold Company, 135 W. 50th Street, New York, New York 10020	This book, a compendium of technical data and descriptive information covering many thousands of chemicals and reactions, is designed for use in industrial situations and can be helpful in assessing a hazardous waste site or spill. However, information pertaining to environmental behavior of chemicals is limited. Three distinct types of information are presented: 1. Technical descriptions of compounds, raw materials, and processes. 2. Expanded definitions of chemical entities, phenomena, and terminology. 3. Description or identification of a wide range of trade name products used in the chemical industry.
9. *Registry of Toxic Effects of Chemical Substances,* U.S. Government Printing Office, Washington, D.C.	This annual publication is sponsored by NIOSH and contains toxic dose data with references to source documents and major standards and regulations for 35,000 chemicals.

Session 14.
Incident Hazard Risk Assessment and Initial Response

Session Objectives
To describe the process of analyzing incidents to determine the presence of hazardous materials and predicting how the hazard may affect shipyard employees and the environment.

Emergency Incidents in the Shipyard

The Operational Level Responder will be the first person to actually take charge of an incident that involves hazardous substances. Therefore, they must be competent in hazard analysis and risk assessment. This is the process of analyzing the hazardous situation for the purpose of commencing initial actions. Initial actions on the part of the Operational Level Responder include the following:

1) Protection of humans and the environment (area safety, control, and containment)
2) Respond defensively (not actually stopping the leak, unless totally safe to do so)
3) Safely contain the release to keep it from spreading and further exposure (safe distance)

The evaluation of information and the assessment of relative risk is one of the most critical points in the decision making process at a hazardous materials incident. Facts concerning hazards and risks must be gathered and analyzed before specific actions can be made.

Hazard and Risk Assessment

The hazard and risk assessment provides the basis for decision making at the scene of a hazardous materials incident. Hazard and risk assessment simply means to "size-up" the situation at hand. It is a process of taking all the factors involved, weighing them, and arriving at a sound decision.

- Chemical hazard analysis for environmental health and safety
- Site safety and environmental site characteristic risk assessment
- Risk evaluation and visualizing potential outcomes for determining initial response actions

Chemical Hazards of the Substance

In hazardous materials related incidents a hazard risk refers to the hazardous chemical and physical properties that have a potential for causing damage to life, the environment and/or property. The chemical hazard analysis includes identifying the materials involve and their associated hazard risks to employee health and the environment. Placards, container labels, MSDS', NAERG96, and/or knowledgeable persons on the scene are valuable information sources for preliminary hazard assessment. Evaluate all available information as discussed in previous sessions and consult the recommended guidance to reduce immediate risks.

- Locate and review the MSDS
- Identify the Hazardous Material Label
- Look up the Material in the NAERG96

Preliminary Risk Assessment

The definition of risk is the probability that damage to life, property, and/or the environment will occur. The risk can be considered greatest when the responder does not know the types of

substances involved. This is why Level A/B protection is required when the materials are unknown. Risk assessment considerations include the following:

- Quantity and Toxicity of Materials
- The Exposure Potential to People, Property and the Environment
- Size, Type, and Condition of Container
- The Levels of Resources Available
- The Weather Conditions and the Site Terrain

Evaluating Risk

Risk evaluation is the analysis of the "inputs" of the hazard assessment. Specifically the substance involved, the container, the environment in which the incident occurs, and the actions and resources of the response personnel. This hazard risk evaluation requires the responder to visualize the likely behavior of the material and/or its container along with the associated harm and to describe the outcome of that behavior.

Visualize Potential Outcomes

Predicting potential outcomes form the basis of risk evaluation and developing initial response actions. The following is a list of questions that should be asked when visualizing potential outcomes:

- Where will the hazardous material go when it is released during an emergency?
- What humans can be affected by the material release?
- What pathway will the hazardous material and/or the container take to get there?
- How will the hazardous material affect humans or the environment?
- When will the hazardous material become an actual event?
- What harm will the hazardous material cause?

When considering the answers to the above questions, the Operational Responder must take in to account the following factors which affect hazardous material behavior:

- The inherent properties and quantities of substance(s) involved (toxics, corrosives, flammable)
- The built-in characteristics of the container (round, plastic, steel, box, square)
- The natural laws of physics and chemistry (liquids, gases, vapors, solids)
- The pertinent environmental factors: (weather, wind, physical surroundings, slopes, streams)

Hazard and risk assessment is one of the critical tasks in the successful management of a hazardous material incident. An accurate evaluation of the real and potential problems will aid the Operational Level Responder with taking appropriate actions and ensure a safe and effective response. The key elements of the hazard risk evaluation process includes:

- Identifying the material involved
- Gathering information
- Visualizing the hazardous materials behavior
- Predicting outcomes
- Performing proper control and containment

Session 15 Exercise #2.
Incident Hazard Risk Analysis Using MSDS Information and NAERG96

Objectives of the Exercise

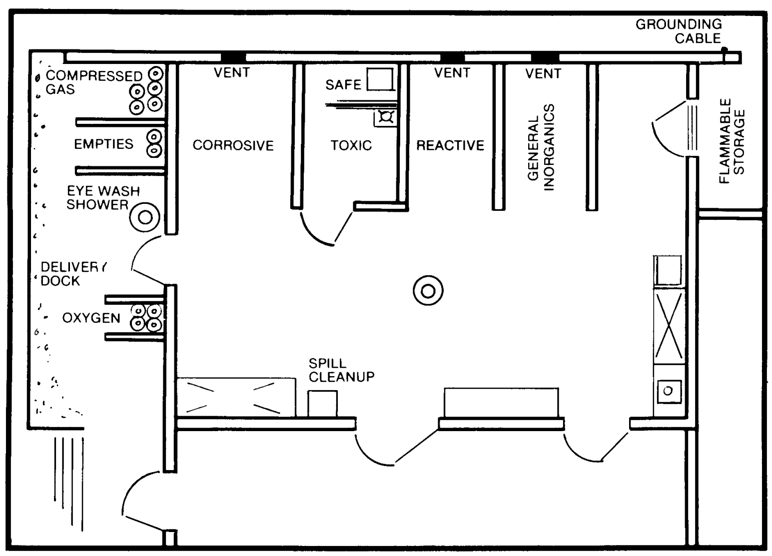
To provide the Operational Level Responder with in-class hands-on exercises to enhance learning. The focus is on Operational Level Response methods for using the MSDS and the NAERG96 for incident hazard risk analysis.

Hazardous Chemical Incident and Chemical Information

At 11:10 am on a Tuesday, a 55 gallon drum of 1,1,1- trichloroethane (TCA, Trichlor) is dropped from a forklift and ruptured on the production floor in the paint shop. No one was injured and flow from the drum has stopped at 50% loss. You can not see the product label but a nearby person has an MSDS readily available. Use the chemical hazards information from exercise #1 to help with your incident hazard risk analysis. The plot plan of the area is provided below. This information, combined with the previous training sessions, should help the Operational Responder identify their responsibilities with respect to this incident. A plot-plan of the incident displays the situation at hand. This will help with the incident hazard analysis work sheet.

Workshop Assignment

Using the information provided on the MSDS for Trichloroethane, and the NAERG96, list the hazards involves with this incident. Fill out the supplied Hazard Analysis Data Sheet and identify the specific dangers involved with this situation, and rank them in order of severity on an additional page.



1) Fill out the NAERG96 Data Information
2) Complete the Incident Hazard Risk Analysis Data Sheet
3) List Your Group Incident Hazard Ranking

Work-Group Format

In groups of 4-6 persons, prepare a preliminary chemical hazard assessment by filling out the Incident Hazard Analysis Data Sheet and the hazard ranking sheet. Have one person represent the group as a spokesman.

Exercise #2 NAERG96 Guide Data

What is the Chemical ID # (s) ____

What is the Guide # ____

POTENTIAL HAZARDS ____
____
____
____

PUBLIC SAFETY CONCERNS ____
____
____
____

EMERGENCY RESPONSE CONCERNS ____________________________________
____
____
____

Exercise #2 Incident Hazard Analysis Data Sheet

Quantity and Toxicity of Materials
What are the material health hazards? ______________________________
What chemical quantities are involved? ______________________________
Is there a fire or explosion potential? ______________________________
What personal protective equipment (PPE) is needed? ______________________________

Potential Exposure to People, Property and the Environment
Are there any victims? ______________________________
Any other potential human exposure, who is at risk? ______________________________
Is there adequate ventilation? (Yes /No) ______________________________
Will the area become **confined space hazard** due to
limited access ______________________________
insufficient ventilation ______________________________
excessive toxicity ______________________________
explosive or combustible fumes and vapors? ______________________________
Event timing concerns ______________________________
Is employee evacuation necessary? ______________________________
Releases to environment (yes / no) ______________________________
What Environmental Threats ______________________________

Size, Type, and Condition of Container
Is the container rusted or corroded? ______________________________
Has the container been punctured or torn? ______________________________
Is the container leaking? ______________________________
Is the container bulging or dented? ______________________________
Is the container potentially exposed to flame or heat? ______________________________

Levels of Resources Needed and Available
Is monitoring or sampling required ? ______________________________
Is there a need for further resources? ______________________________
Is notification required ? ______________________________
What resources (human and equipment) are required and are readily available? ______________________________

What can be done immediately? ______________________________
- Is diking necessary? ______________________________
- What containment equipment is readily available? ______________________________

Weather Conditions and the Site Terrain
What are the weather conditions? ______________________________
Is it raining or is it a hot, dry day? ______________________________
What is the topography. Is it flat, are there hills? ______________________________
Will the topography affect the approach considerations or evacuation considerations? ________
- What is the terrain like? ______________________________

Exercise #2 Incident Hazard Ranking

Group Member Names:

____
____
____
____
____
____

1) ____
Explain: ____

2) ____
Explain: ____

3) ____
Explain: ____

4) ____
Explain: ____

5) ____
Explain: ____

Session 16.
Shipyard Procedures for Incident Control, Containment, and Confinement (Defensive Strategies)

Session Objectives
To describe the function of hazardous substance incident control, containment and confinement procedures in the shipyard. Also, this session describes the importance of site control zones.

Incident Control

One of the most important subjects for the Operational Level Responder to understand is the process of risk assessment and hazard awareness. These subject have been discussed in detail throughout this training program. Knowing the hazards associated with chemicals is very important for comprehensive understanding of control, containment and confinement actions.

The first priority is always protection of employee safety and health. Those involved with the incident must be cared for without putting the Operational Responder in danger. This can not be over emphasized. Once the emergency response notification system is initiated and any immediate safety response has been conducted, incident control, containment and confinement can commence.

When and incident happens that involves a hazardous substance, the substance should initially be treated as if it is an extremely hazardous chemical with toxic fumes and potential for fire. In other words, until you have better information, worse case scenario should be assumed. The most important issue is the life and health of you and fellow employees. This is the first step in the hazard analysis.

Employee Safety

Any efforts made to rescue persons, protect property or the environment must be weighed against the possibility that you could become part of the problem. Enter the area only when wearing appropriate protective gear. Operational Level Responders will generally have a low level of protection and will not enter into potentially toxic environments. Operational Responders should perform the following:

- Assist individuals potentially contaminated by the chemical.
- Approach the incident from up-wind. Resist the urge to rush into the incident area, employees cannot be helped if the would be rescuer is seriously harmed by the incident hazards.
- Secure the scene without entering the immediate hazard area. Isolate the area and assure the safety of people and the environment around the incident. Set-up a safety perimeter and keep people away from the area. Allow enough room to move and remove equipment and response personnel.
- Do not walk into or touch spilled material. Avoid inhalation of fumes, smoke and vapors, even if no hazardous substances are known to be involved. Do not assume that gases or vapors are harmless because of lack of a smell. Odorless gases and vapors may be very harmful.

Safely Slow or Stop the Source

In many cases, stopping the release is the first order of business during a hazardous materials incident. If the release is not stopped, it can be difficult, if not impossible, to contain the spill. In

some cases, it will be easy and safe to stop the source, and in other cases, it will be impossible for the Operational Level Responder to stop the source.

The following are practices that an Operational Responder may potentially perform to stop or slow the source of a hazardous substance spill or leak:

1. Uprighting the container
2. Rolling a punctured drum over so that the hole is upward
3. Shutting off valves leading to a leaking or bursting pipe
4. Plug the leak (only if can be done w/out personal contamination)

Get Help On The Way - Make internal notification

Make notification to the on-site emergency notification system. It is frequently advisable to have an associate who is trained in Operational Level Response to perform the notification while you are attending to other matters. If nobody is available to help, you must perform notification as soon as possible. This will help to ensure assistance from qualified fire fighting, medical and hazardous materials response personnel.

Protective Actions, Isolation and Evacuation

Protective Actions are those steps taken to preserve the health and safety of emergency responders and the employees during an incident involving releases of hazardous substances. Initial Isolation and Protective Actions are taken to ensure that employees in areas that could be affected by a cloud of dangerous gas are evacuated and/or protected.

Isolate the hazardous area and deny entry to keep everybody away from the area if they are not directly involved in emergency response operations. Unprotected emergency responders should not be allowed to enter the isolation zone. This “isolation" task is done first to establish control over the area of operations. This is the first step for any protective actions that may follow.

To perform evacuation, there must be enough time for people to be warned, to get ready, and to leave an area. If there is enough time, evacuation is the best protective action. Begin evacuating people nearby. When additional help arrives, expand the area to be evacuated downwind and cross-wind. Even after people move to the distances recommended, they may not be completely safe from harm. They should not be permitted to congregate at such distances. Send evacuees to a definite place, by a specific route, far enough away so they will not have to be moved again if the wind shifts.

Segregation and confinement are the most important Operational Level Responder function that must be performed in a hazardous substance incident. They work together to protect the general employees form potential contamination. Segregation involves the process of moving the people away from the source (i.e. evacuation) and controlling access to the area. Similarly, confinement works towards leaving the employees where they are and confining them from the incident.

Segregation and Access Control

Boundary tape
Control access points
Control personnel in the incident area
Move people away to a safe are
Initiate evacuation

Confinement

Turn off air conditioning and ventilation
Close windows and doors
Minimize people movement which creates air movement

In-place protection or confinement is a term that describes people inside a building that should remain inside until the danger passes. In the case of short-term spills and toxic vapor clouds, the material may be deflected by a multistory building and pass by without affecting the occupants of the building. In-place protection is used when evacuating the public would cause greater risk than staying where they are, or when an evacuation cannot be performed.

Direct the people inside to close all doors and windows and to shut off all ventilating, heating and cooling systems. In-place protection may not be the best option if (a) the vapors are flammable; (b) if it will take a long time for the gas to clear the area; or (c) if buildings cannot be closed tightly.

Spill Containment From the Environment and Employees

Containment of spill and hazardous incidents is an important concept that Operational Responders must understand. Containing releases will minimize the potential for environmental damage or personal chemical exposure outcomes. Containment is sometimes the best form of defense when the material is spilled and the Operational Level Responder has limited PPE. Containment involves minimizing the amount of area to which a spill or hazardous situation can extend. For example, a berm can be used to contain a liquid spill from entering a storm drain or entering another room. Similarly, doors and windows can be closed to eliminated the migration of fumes and vapors to other rooms in a building. Providing for containment will makes for easier clean-up operations and can protect the environment. All containment procedures performed by the Operational Responder must be safely with very low risk of chemical exposure.

The following is a list of containment procedures that may be performed by an Operational Level Responder:

Containing Solids: Hazardous solids are generally the easiest to contain. Primarily because solids do not flow far from the initial point of release. When containing solids, it is necessary to rope off the area to prevent foot or vehicle traffic from tracking of the substance. Solids can be tracked away by shoes, tires, clothing and sometimes wind. With solids, it is important to remember not to increase their mobility by mixing with water or other liquids.

Containing Liquids: Liquids can be a little more difficult to contain. In addition to roping off the area, liquid spills require an emphasis on containment of liquid spillage. In some cases, containment may already be in place. This is called secondary containment. The shipyard generally has secondary containment around large tanks and in hazardous materials/waste storage areas. Although, when containment is not in place, temporary berms and dikes need to be deployed to contain the spill. Temporary berms can be constructed of dirt, sand, absorbent, blocks, specially designed foam packs, and a variety of other measures. In some cases it may be more advantageous to “herd” or directed the liquids by using ditches, channels, swales and berms and other means to an existing low point. This will allow the liquid to pool in a contained area making clean-up much easier. In some case, the low area will be a storm or floor drain. Ensure that the drain is plugged and sealed. ***Avoid having liquid spills leak into storm drains or sewer drains***.

Containing Gasses: Gasses and vapors are very difficult to contain. Material vapors escaping from a building may be potentially controlled by closing windows and doors. Vapors tend to stay together

and move upward or downwind. If the vapor density is greater than air, the vapor will tend to gravitate towards the ground layer. If the vapor density is greater then air, the vapor will tend to float and move towards the ceiling.

Site Control

Site control is based on the principle of establishing various zones to control and reduce the accidental spread of contaminants by workers or equipment. The possibility of exposure to hazardous substances or transfer of contaminants can be reduced or eliminated in a number of ways including:

- Setting-up security and physical barriers (Site Control Zones)
- Establishing work zones within the site
- Establishing control points to regulate access to work zones
- Minimizing the number of personnel and equipment on-site consistent with effective operations
- Conducting operations in a manner to reduce the exposure of personnel and equipment, and to minimize the potential for airborne dispersion
- Implementing appropriate decontamination procedures

The risks associated with hazardous materials response will never be completely eliminated, but they can be successfully managed.

Site Control Zones

One method of site control is to set-up Site Control Zones that specifically prescribe response operations and procedures. Movement of personnel and equipment between Zones is limited by access control points. The establishment of such zones helps ensure that personnel are protected against the hazards present in each area. Similarly, contamination is confined to specific regions, and personnel can be located and evacuated during an emergency. Three contiguous zones are frequently used for hazardous emergency response and are listed below:

Zone 1: Exclusion Zone, the immediate contaminated area
Zone 2: Contamination Reduction Zone (CRZ), the area where decontamination takes place
Zone 3: Support Zone, an uncontaminated or "clean" area

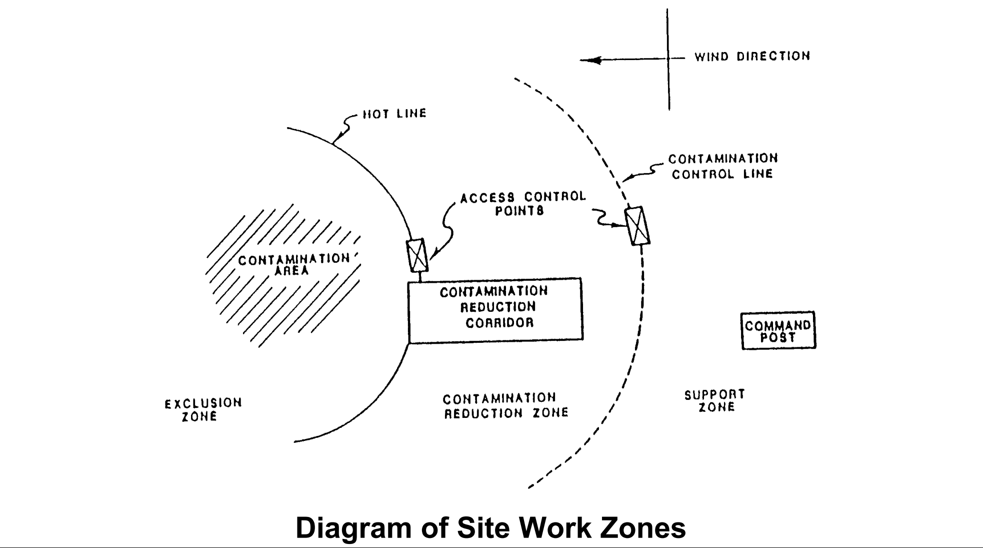


Diagram of Site Work Zones

Zone 1: Exclusion Zone

The Exclusion zone is also referred to as the Hot Zone, Red Zone, or Inner Perimeter. It is the innermost of the three areas and is the zone of initial contamination. All people entering the Exclusion Zone must wear prescribed levels of protection. PPE will either be Level A, B, or C. An entry and exit checkpoint must be established at the boundary of the Exclusion Zone to regulate the flow of personnel and equipment into and out of the exclusion zone.

The outer boundary of Zone 1, the Hotline, is initially established by visually surveying the immediate environs of the incident and determining the locations of any hazardous substances and their orientation of any drainage pathways, wind direction, and employee density. Additional factors that should be considered include the distances needed to prevent fire or an explosion from affecting personnel outside the zone, the physical area necessary to conduct site operations, and the potential for contaminants to be blown from the area. Once the Hotline has been determined, it should be physically secured and clearly marked by lines, placards, hazard tape or signs, or enclosed by physical barriers such as chains, fences, or ropes. During subsequent site operations, the boundary may be modified and adjusted smaller or larger as more information becomes available.

The Operational Responder will develop the first “Exclusion Zone”. This preliminary Exclusion Zone will be modified once the Technician Level Responder and Incident Commander arrives on-scene.

Zone 2: Contamination Reduction Zone (CRZ)

The Contamination Reduction Zone (CRZ) is also referred to as the Warm Zone, Yellow Zone, and the Secondary Perimeter. This area is the transition area between the contaminated area and the clean zone. The CRZ serves as a buffer to further reduce the probability that the clean zone will become contaminated or be affected. It provides additional assurance that the physical transfer of contaminating substances on people, equipment, or in the air, is limited through a combination of decontamination, distance between Exclusion and Support Zones, air dilution, zone restrictions, and work functions.

Initially, the CRZ is considered to be an uncontaminated area. At the boundary between the Exclusion and CRZ are Contamination Reduction Corridors (decontamination stations) established. Exit and entry to and from the Exclusion Zone is through a Contamination Reduction Corridor. As operations proceed, the area around the decontamination station may become contaminated, but to a much lesser degree than the Exclusion Zone.

Access to the CRZ from the Support Zone is also through a control point. Personnel entering the CRZ wear the prescribed personnel protective equipment required for working in the CRZ. Entering the Support Zone requires removal of any protective equipment worn in the Contamination Reduction Zone.

Zone 3: Support Zone

The Support Zone, the outermost part of the site, is considered a uncontaminated or clean area. Support equipment (command post, equipment trailer, etc.) is located in this zone, and traffic is restricted to authorized response personnel. This zone is also called the Cold Zone, Green Zone,

and the Outer Perimeter. No protective clothing is needed in this area. Since normal work clothes are appropriate within this zone, potentially contaminated personnel clothing, equipment, and samples are not permitted, but are left in the CRZ until they are decontaminated.

Support zone personnel are responsible for alerting the proper agency in the event of an emergency. All emergency telephone numbers, evacuation procedures and maps, and vehicle keys should be kept in the Support Zone. The location of the command post and other support facilities in the Support Zone depends on a number of factors such as:

Accessibility and topography: Open space available, vehicle access, spill flow grade.

Wind direction: Preferably the support facilities should be located upwind of the Exclusion Zone. However, shifts in wind direction and other conditions may be such that an ideal location based on wind direction alone does not exist.

Resources: Adequate roads, power lines, water, and shelter.

Visibility: Should have a clear line of sight to all activities in the Exclusion Zone.

Distance: As far from the Exclusion Zone as possible, while retain effective communications.

Every Incident Is Different

Every hazardous substances incident is different. Each will have special problems and concerns. Action to protect the yourself, employees, and the environment must be selected carefully. Correct information and hazardous assessment can help with initial decisions. Once a higher level responder (i.e. Technician Level Responder or Incident Commander) arrives, they must continue to gather information and monitor the situation until the threat is fully removed. You function as Operational Level Responder will be to assist in crowd control outside of the contaminated area.

Session 17.
Operational Level Responder Safety In An Emergency Situation

Session Objectives
To provide instruction on how Safety is the first thought in a hazardous substance emergency situation and describe a cautious approach with perimeter control.

First Operational Thought: Safety

The main concern of the Operational Level Responder is that of human life and health. This includes any potential victims but most of all, the Operational Level Responders own health. In other words, minimizing the likelihood of putting yourself in danger is of utmost importance. Three techniques designed to ensure safety when responding to a hazardous substance incident are as follows:

- Use a safe approach
- Perform safe chemical and incident hazardous assessment
- Follow the hazardous incident safety rules

Use A Safe Approach
Using a safe approach is one of the most important steps that an emergency responders can take. A safe approach involve analysis the incident and determining a method for approach. It includes keeping a safe distance and direction. Safe distances can be determined by the severity of the incident (100 to 1000 feet away). The other important safe approach issues is direction. This will generally be up-wind, up-grade, and/or up-stream. Always maintain a safe distance as well as direction.

Perform Safe Chemical and Incident Hazardous Assessment
Performing a safe site assessment means attempting to identify the extent of the hazard without putting yourself in danger. This can be accomplished using the following **Incident Safety Rules:**

1) Be cautious treating all materials as extremely hazardous until proven otherwise

2) Approach from up-wind, up-stream, and/or up-hill

3) Keep a safe distance from the incident until an accurate site assessment has be made

4) Isolate and deny entry into the hazard area

5) Do not rush to victims without performing a risk assessment and wearing proper PPE

6) Do not touch, taste, or breath unknown materials (colorless and odorless vapors can kill)

7) Do not eat, drink, or smoke in or near the incident area

8) Eliminate all ignition sources near the incident

9) Establish and observe safety perimeters and control zones

10) Do not worry about looking foolish (human life may be at stake.) Think Safety!

First Operational Responder Priorities

The Operational Responder will safely attempt to isolate and deny entry into the hazardous incident area. Denying entry and isolating the incident area is accomplished by establishing perimeters and control zones. The purpose of these are to help perform the following:

- Ensure safety and isolation
- Control the scene
- Limit contamination spread
- Allow for safe working areas for decontamination and medical attention

The Operational Responder will generally make the first attempt at setting up “Safety Perimeters” while Technician Level Responders will set-up the Control Zones.

The Safety Perimeter and Control Zones Defined

Safety Perimeter
A safety perimeter is a line that is outside of all control zones. It sometimes ends up being the Support Zone. This Safety Perimeter is the area were people located around the incident area should muster and insure that required evacuation has occurred.

Control Zones: (There are Three basic Control Zones)

1) Exclusion or Hot Zone: Requires the most protective equipment and only Technician Level responders with specific task and proper level of protective clothing are allowed in this Zone.

2) Contamination Reduction (CRZ) or Warm Zone: Used to control areas like safe refuge, and decontamination. This area is usually a reduced protective clothing level area and is located up-wind, up-hill, and/or up-stream. If the wind direction should change, this area may need evacuation.

3) Support or Cold Zone: Safe area for the Incident Command Post, medical aid and other emergency responders. No protective clothing is required in this area. Initially, this zone will be the Safety Perimeter. As the Incident progresses, employees are asked to move back into a safer area and a Support Zone is created. If people do not have a role in the response, they must move back to the Safety Perimeter.

The Operational Level Responder must remember the three main safety perimeter control objectives:

1. Control "Entry Points" (doors, gates, intersections, etc.);
2. Control "Perimeter" around all Entry Points; and
3. Control "Access" inside including other Operational Level Responders

Setting Up Safety Perimeters and Control Zones

Each incident will be different and must be treated based on individual characteristics. Specific characteristics include:

- Area configuration
- Chemicals involved
- Number of people
- Victims
- Weather
- Potential for fire and explosion
- Back-up response time

All of the hazardous incident characteristics will need to be accessed when setting up Control Zones and Safety Perimeters. The main principles and practices used to establish Safety Perimeters and Control Zones are:

1. First Determine a Visual Inner Perimeter that is likely to become the Exclusion Zone.
2. Set-Up outer perimeter securing all entry points (consider work space for Zones).
3. Downwind perimeter should be larger (2 or 3 times larger).
4. Unmanned barricades are usually ineffective.
5. Watch for ignition source (vehicles, welding, smoking, etc.).
6. Try to use natural barriers to your advantage.
7. Deny entry to all unauthorized personnel, including responders, Control "Access" inside perimeter, including other Operational Level Responders.
8. The Incident Commander will be ultimately responsible for Perimeters and Control Zones They will set-up tactical plans and pre-arranged logistics to manage the incident.

Remember The First Operational Level Responder Thought Must Always be SAFETY

Must have "Positive" vs. "Negative" safety attitude

- Negative safety attitudes think safety is overkill can result in injury and even death
- Think safety first, last and always
- Use a go SLOW Approach in a Hazardous Materials event
- A Quick vs. go SLOW Haz Mat response can kill or injure you and others.

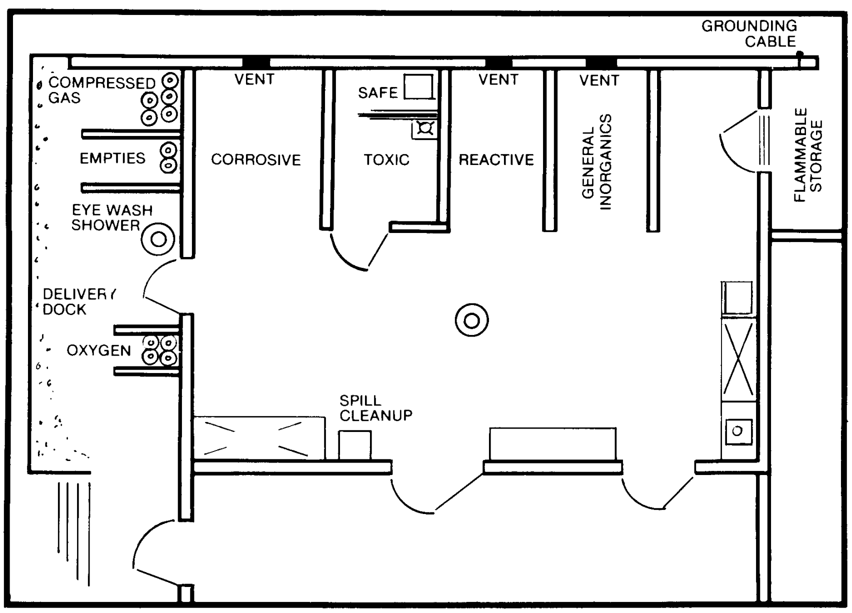
Session 18 Exercise #3. Incident Control, Containment, and Confinement (Defensive Strategies)

Objectives of the Exercise
To provide in-class hands-on exercises focusing on Operational Level Response initial incident control, containment and confinement actions.

Hazardous Substance Incident Information

At 11:10 am on a Tuesday, a 55 gallon drum of 1,1,1- trichloroethane (TCA, Trichlor) is dropped from a forklift and ruptured on the production floor in the paint shop. No one was injured and flow from the drum has stopped at 50% loss. You can not see the product label but a nearby person has an MSDS readily available. In previous exercises you have evaluated the hazards posed by the spilled substance. A plot plan of the area is provided below. This information combined with the previous training sessions should help the Operational Responder identify their responsibilities with respect to this incident.

Plot-Plan Display



Workshop Assignment

Using the information provided on the MSDS for Trichloroethane, and any other information available, list e step, in sequence, you feel necessary to respond to this incident.

Work-group Format

Work in groups of 4-6 persons to prepare a written hazard assessment. Select one person be the group spokesman.

Containment and Control Methods Worksheet

What is your containment and control approach as an initial Operational Level Responder at this incident. The following worksheet is provided to outline some of the possible considerations in evaluating control and containment options to protect persons property and the environment.

Action Options:

The following table provides questions that are designed to generate ideas about what actions should be taken by the Operational Level Responder in a hazardous substance incident. The table outlines ideas and questions for the following four (4) action options:

1. No Hazardous Intervention
2. Hazard Containment
3. Hazard Control and Clean-Up
4. Hazard Confinement and Evacuation

Action Options	Ideas and Actions
1. No Hazardous Intervention	Operational Level Responders who have a positive safety attitude will understand that this is frequently the best option. Do you know the chemical hazards involved? Is the situation extremely dangerous? Do you have the proper Personal Protective Equipment? Is it best to simply isolate the area and deny entry or prevent access?
2. Hazard Containment	Is diking or otherwise build a dam control or confine a liquid an option? Should you use material to cover a floor drains and man holes? Should you retain or hold back, hold secure or intact (in natural low area)? Should you divert the course of the spill?
3. Hazard Control and Clean-Up	Is uprighting the container a safe option? Can you roll a punctured drum over so that the hole is upward? Will shutting off valves control the source? Will dispersing and spreading the hazard be helpful? Can you safely plug the leak with hazardous response equipment Should you dilute and diminish the chemical strength of the substance? Should you absorb the materials to clean-up the spill?
4. Hazard Confinement and Evacuation	Should the area be evacuated? To what extent? What are the evacuation options? Should the spill area be confined? Should air quality confinement or ventilation be initiated? Where should control zones be set up? Exclusion Zone (Hot Zone or Inner Perimeter) Contamination Reduction Zone (Warm Zone or Secondary Perimeter) Support Zone (Cold Zone or Outer Perimeter)

Exercise #3 Initial Incident Control and Containment

Group Member Names:

Please List the **action steps** in order of sequence after incident command notification:

Step #1)

Explain:

Step #2)

Explain:

Step #3)

Explain:

Step #4)

Explain:

Step #5)

Explain:

Session 19.
Basic Personal and Equipment Decontamination Procedures

Session Objectives
To explain the purpose and the process of personal, area, and equipment decontamination procedures.

Personal Decontamination (If a Person is Exposed to a Chemical)

If a person gets corrosive, toxic, or dangerous chemical on them, the following procedure must be immediately initiated:

Flush the affected area with running water for at least 15 minutes remove any contaminated clothing while the victim is under the running water The victim and involved rescuers must be taken for immediate medical attention

This procedure must be followed regardless of the extent of contamination. The source of the running water is not as important as the water itself. If a drench shower is immediately available, use it. Hoses, sink water, etc., all can be used successfully. After the initial decontamination, the victim may become progressively colder and more prone to shock. If possible, the responder should transfer the victim to a source of tempered water, such as a regular shower, and use water at body temperature for the remainder of the decontamination. If possible, the victim's affected areas must be continually flushed during transfer.

Decontamination

Decontamination is the process of removing and/or neutralizing hazardous contaminants from workers, PPE, work areas and response equipment. Decontamination helps prevent transport of substances from the incident site to clean areas and the surrounding community. Additionally, decontamination can be critical to the maintenance of worker health and safety. Decontamination procedures can effectively prevent the contamination of respirators, clothing, and other personal protective equipment. Decontamination is important for the following reasons:

- It prevents workers from contamination when removing (doffing) their PPE
- It protects workers' families from contamination when workers return home
- It protects non-contaminated areas from becoming contaminated
- It protects the surrounding environment and community

Personnel responding to hazardous substance incidents may become contaminated in a number of ways, including:

- Contacting vapors, gases, mists, or particulates in the air
- Being splashed by materials while sampling or opening containers
- Walking through puddles of liquids or on contaminated soil
- Using contaminated instruments or equipment

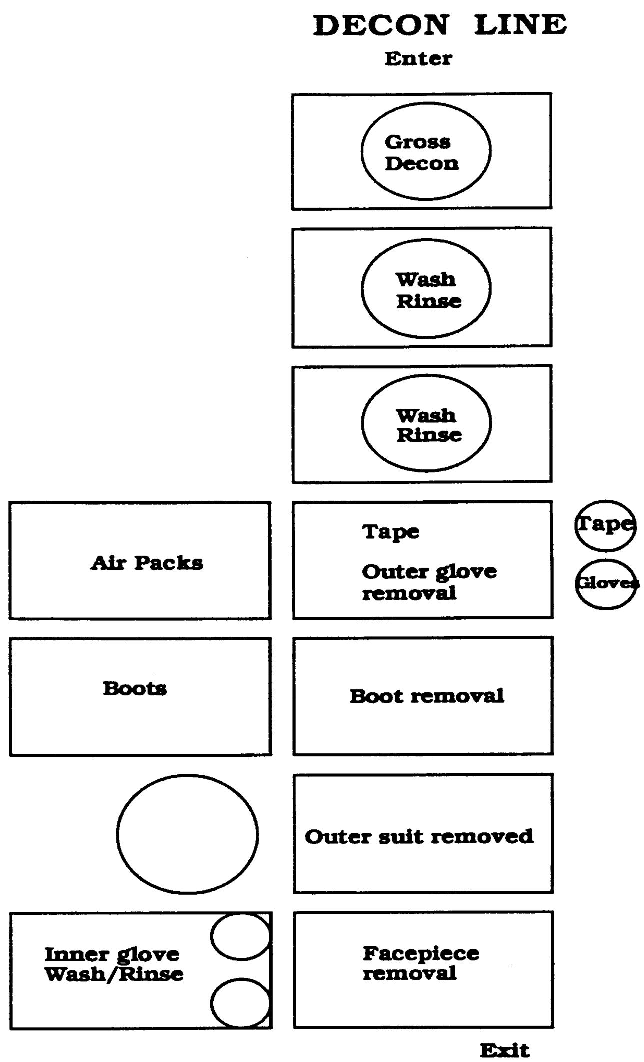
The Process of Decontamination

Protective clothing and respirators help prevent the wearer from becoming contaminated during clean-up, while good decontamination practices reduce contamination of the environment, workers families, clean areas, and the public.

While removing contaminated clothing, personnel have the potential to be exposed to chemicals. To prevent such occurrences, methods to reduce contamination and decontamination procedures must be developed, established, and modified when necessary.

Decontamination consists of physically removing contaminants or changing their chemical nature. How extensive decontamination must be depends on a number of factors. The more harmful the contaminant, the more extensive and thorough decontamination must be. Less harmful contaminants may require less decontamination.

During hazardous substance incidents, personnel protective equipment, sampling tools, and other equipment are usually decontaminated by scrubbing with detergent water using a soft-bristle brush followed by rinsing with water. Be aware that some chemicals may react further or have their toxicity compounded by the presence of water. Specific "Decontamination" chemicals may be used if they are specific to identified contaminants. The diagram provides a basic flow of the decontamination process:



Decontamination Levels

Combining emergency response decontamination procedures, correct methods of doffing PPE, and using of site work zones substantially minimizes cross-contamination from protective clothing to wearer, equipment to personnel, and from one area to another. Only general guidance can be given on methods and techniques for decontamination. The exact procedure to use must be determined after evaluating a number of factors that are specific to the incident. For example, a typical decontamination plan assumes no information is available about the degree of contamination at the site. Specific conditions at the site will be evaluated including:

- Type of contaminant
- Amount of contamination
- Levels of protection required
- Specific types of protective clothing worn

The initial decontamination plan should assume a worst-case scenario, where all equipment and personnel leaving the Exclusion Zone are grossly contaminated. A means should be available for personnel to remove, wash, and rinse (at least once) all the protective equipment worn.

The initial decontamination plan is then modified, eliminating unnecessary steps or otherwise adapting it to fit the specific site conditions. For instance, the initial plan might require a complete wash and rinse of chemical protective garments. If disposable garments are worn, the wash/Rinse step could be omitted. Wearing disposable boot covers and gloves could eliminate washing and rinsing these items.

Decontamination of the Work Area (Returning to Normal Operations)

The end result of the decontamination is to render the area safe for routine maintenance and operations. Careful actions on the part of the responders can reduce the total work of decontamination. The exact method of decontamination depends upon the unique circumstances of the spill. For a typical "in-plant" spill, the first step is to remove all gross contamination. If the spilled chemical is volatile, ventilation is frequently sufficient. If further clean-up must be performed, each step should reduce the total level of contamination. After the gross contamination is removed, the area can be inspected to identify remaining "hot-spots". These can be cleaned or neutralized, as appropriate. Care must be taken to examine under and behind equipment.

When the level of contamination is reduced sufficiently, the level of personal protective equipment used by the responders can be correspondingly reduced. A typical sequence might occur as follows: 1) SCBA with Saranex Coveralls required, 2) full-face air purifying respirators with Saranex coveralls required; 3) full-face air purifying respirators with Nomex work uniforms require, and finally, 4) normal work clothes. Such changes in level of protection must be authorized by the Incident Commander.

A final wash down of the area with detergent and water is useful. If floor drains are not available or inappropriate, the wash water should be removed with an industrial wet-dry vacuum. Such vacuums, when protected with proper filtration also can be used to pick-up residue from various stages of the clean-up effort. Also, all wash water and contamination must be disposed properly as required by local state and federal regulations.

Only when the area is rendered safe for re-occupancy and all spill residue waste is transferred to the hazardous waste accumulation area, and all spill response equipment is ready for another incident can the clean-up be considered complete.

Decontamination of Response Equipment

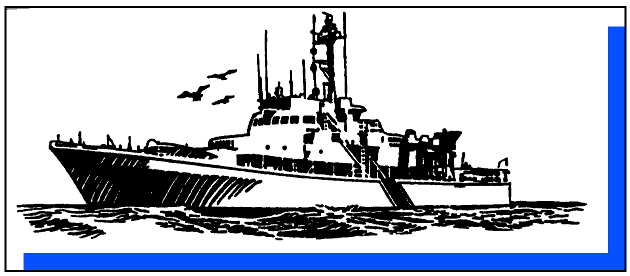
All spill response equipment must be cleaned and made ready for use immediately upon completion of the clean-up work. Disposable items, such as suits and gloves must be replaced. Neutralizer and sorbent pads supplies must be restocked.

Recommended Decontamination Equipment

Equipment For Decontamination
- Drop cloths of plastic or other suitable materials on which heavily contaminated equipment and outer protective clothing may be deposited.
- Collection containers, such as drums or suitably lined trash cans, for storing disposable clothing and heavily contaminated personal protective clothing or heavily contaminated equipment that must be discarded.
- Lined box with absorbents for wiping or rinsing off gross contaminants and liquid

	contaminants.
-	Stock tanks or children's wading pools to hold wash and rinse solutions. These should be at least large enough for a worker to place a booted foot in, and should have either no drain or a drain connected to a collection tank or appropriate treatment system.
-	Wash solutions selected to wash off and reduce the hazards associated with the contaminants.
-	Rinse solutions selected to remove contaminants and contaminated wash solutions.
-	Long-handled, soft-bristled brushes to help wash and rinse off contaminants.
-	Paper or cloth towels for drying protective clothing and equipment.
-	Lockers and cabinets for storage of decontaminated clothing and equipment.
-	Metal or plastic cans or drums for contaminated wash and rinse solutions.
-	Plastic sheeting sealed pads with drains, or other appropriate methods for containing and collecting contaminated wash and rinse solutions spilled during decontamination.
-	Shower facilities for full body wash or, at least, personal wash sinks (with drains connected to a collection tank or appropriate treatment system).
-	Soap or wash solution, wash cloths, and towels for personnel.
-	Lockers or closets for clean clothing and personal items.

HazMat Technician Responder Training



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National Shipbuilding Research Program
SP-1 Panel

Table-of-Contents For HazMat Technician Responder Training

Session 1. Introduction to the Shipyard Hazardous Materials Technician Requirements and List of Courses Objectives

Hazardous Materials Technicians OSHA 1910.120

The Occupational Safety and Health Act (OSHA) of 1970 is the first federal law to provide legal health and safety rights to many American workers. The Superfund Amendments and Reauthorization Act (SARA) requires OSHA to develop requirements for the health and safety training of hazardous waste workers and emergency responders. These requirements are found in the Code of Federal Regulations (CFR) 29:1910.120.

The regulations were effective on March 6, 1990. These regulations were enacted to provide protection to workers at hazardous waste sites and those responding to emergencies involving hazardous substances at any location. Incorporated by reference into these regulations are the OSHA "Right to Know" standards. These standards require employers covered by these regulations to ensure that workers are trained in specific competencies in order to perform their duties in a safe manner and avoiding exposure to chemical and physical hazards.

Section (q) of the regulation applies directly to Emergency Response. This section describes various types of responders such as First Responders (Awareness Level), First Responders (Operational Level), Hazardous Material Technicians, Hazardous Material Specialists and Incident Commanders. The Hazardous Material Technicians respond to releases or potential releases of hazardous substances for the purpose of stopping the release. They assume a more aggressive role than a first responder at the operations level in that they will approach the point of release in order to plug, patch, or otherwise stop the release of a hazardous substance. Hazardous materials technicians receive at least 24 hours of training equal to the first responder operations level, in addition have competency in the following areas:

1. Know how to implement the employer's emergency response plan.
2. Know the classification, identification, and verification of known and unknown materials by using field survey instruments and equipment.
3. Be able to function within an assigned role in the Incident Command System.
4. Know how to select and use proper specialized chemical PPE provided to the hazardous materials technician.
5. Understand hazard and risk assessment techniques.
6. Be able to perform advanced control, containment, and/or confinement operations and rescue injured or contaminated persons within the capabilities of the resources and PPE available with the unit.
7. Understand and implement equipment, victim, and rescue personnel decontamination procedures.
8. Understand termination procedures.
9. Understand basic chemical and toxicological terminology and behavior.

Emergency Response

The standard applies to emergency responders who will perform remedial actions during emergencies involving hazardous wastes, chemicals, materials, and substances which may occur during transportation and at facilities where releases or potential releases may be imminent. Perhaps the most difficult situation to determine the applicability of these regulations are spills or other releases at manufacturing or warehousing facilities storing or using hazardous materials or chemicals. The definition of an emergency as outlined in the OSHA regulations states that:

"Emergencies are response efforts by employees outside the immediate release area or by other designated responders." This definition includes an exemption about situations not covered by the standard. These situations are termed "incidental releases." Incidental releases are those incidents where the material can be absorbed, neutralized, or otherwise controlled at the time of release and there is no safety hazard or potential for exposure. These response activities must be performed by persons within the immediate area or by facility maintenance personnel. This is where the difficulty of determining the applicability of the regulations occurs. In simple terms, if there is no potential for safety hazards or chemical exposure, the regulations are not applicable.

NFPA 472 Competencies for the Hazardous Materials Technician

The National Fire Protection Association (NFPA) has also outlined competency requirements for Hazardous Materials Technicians. NFPA is actively involved with this requirement because the majority of Hazardous Materials Technicians are also fire fighters.

Introduction: Hazardous materials technicians shall be trained to meet all requirements at the first responder awareness and operational levels and at the technician level. In addition, hazardous materials technicians shall be provided medical surveillance, as required, and shall receive any additional training to meet applicable United States Department of Transportation (DOT), United States Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), and other appropriate state, local, or provincial occupational health and safety regulatory requirements.

Definition: Hazardous materials technicians are those persons who respond to releases or potential releases of hazardous materials for the purpose of controlling the release. They are expected to use specialized chemical protective clothing and specialized control equipment.

Goal: The goal of training at the technician level is to provide the hazardous materials technician with the knowledge and skills to perform response tasks safely. In addition to being competent at both the first responder awareness and operational levels, the hazardous materials technician be able to:

A. Analyze a hazardous materials incident to determine the magnitude of the problem, in terms of outcomes, by completing the following tasks:

1. Survey the hazardous materials incident to identify special containers involved, to identify, or classify unknown materials, and to verify the presence, and concentrations, of hazardous materials through the use of monitoring equipment.
2. Collect and interpret hazard and response information from printed sources, technical sources, computer data bases, and monitoring equipment.
3. Determine the extent of damage to containers and the extent of the potential release.
4. Predict the likely behavior of released materials and their containers when multiple materials are involved.
5. Estimate the size of an endangered area using modeling, monitoring equipment, specialists in this field, and using common sense based on knowledge to the surrounding environmental conditions.

B. Plan a response within the capabilities of available personnel, personal protective equipment, and control equipment by completing the following tasks:

1. Identify the response objectives for hazardous materials incidents.
2. Identify the potential action options available by response personnel to achieve the objectives
3. Select the proper Personal Protective Equipment (PPE) required for the given action options.
4. Select the appropriate decontamination procedures for the hazards involved.
5. Develop a plan of action, including safety considerations, consistent with the local emergency response plan and the organizations standard operating procedures, and within the capability of the available personnel, PPE, and control/containment equipment.

C. Implement the planned response to favorably change the outcomes consistent with the organization's standard operating procedures and/or a site safety plan completing the following tasks:

1. Perform the duties within the shipyard incident management system.
2. Don, work in, and doff appropriate personal protective clothing including, but not limited to, both liquid splash and vapor protective clothing with appropriate respiratory protection.
3. Perform the control functions identified in the plan of action.

D. Evaluate the progress of the planned response by completing the following tasks:

1. Evaluate the effectiveness of the control functions.
2. Make modifications as necessary to maintain control.

E. Terminate the incident by completing the following tasks:

1. Assist in the incident debriefing.
2. Assist in the incident critique.
3. Provide reports and documentation of the incident.

Hazardous Materials Technician List of Course Objectives

The objectives for this course are to provide the Hazardous Materials Technician student with the abilities and understanding to perform the following:

- Recognize significant federal and state laws and regulations pertaining to hazardous materials and hazardous waste, as well as some of the key provisions of each law and regulation. Describe their rights and responsibilities under OSHA regulations and related laws.

- Recognize and perform accepted safety practices common to the industrial setting. Identify accident prevention concepts.

- Understand the key components of the shipyards hazardous materials emergency response plan and their individual roles and responsibilities.

- Describe the components of a site safety plan for a hazardous materials incident and identify key points that should be made in a safety briefing prior to working on the scene.

- Understand the basic Incident Command and Scene Management concepts as they apply to hazardous materials incidents and the shipyard.

- Describe the basic duties of each position within the Hazardous Materials Group, to include: the Hazardous Materials Group Supervisor, Entry Leader, Decontamination Leader, Site Access Control Leader, Safe Refuge Area Manager, Assistant Safety Officer, Hazardous Materials and Technical Specialist, and finally the Hazardous Materials Reference.

- Recognize the importance of establishing the three control zones that must be established at a hazardous materials incident.

- Understand basic chemical and physical terms and behaviors.

- Know the types of exposure, toxic effects, dose-response relationship and terms used to describe toxicity and environmental conditions at a hazardous materials incident.

- Understand OSHA required Medical Programs including: Medical Surveillance Program and Medical Monitoring Program.

- Understand and use several types of hazard and response information including: reference manuals, hazardous materials data bases, technical information centers (i.e., CHEMTREC) and technical information specialists.

- Understand the various types of respiratory protection to include: Self Contained Breathing Apparatus (SCBA), Supplied Air Respirators (SAR) and Air Purifying Respirators (APR).

- Identify Chemical Protective Clothing including; vapor protective, splash-protective, and support-function clothing. Describe the advantages and disadvantages of each. Identify the four levels of chemical protection (EPA/NIOSH/NFPA) and match both the equipment required for each level and the conditions under which each level is used. Explain the significance of degradation, penetration and permeation as they relate to suit selection.

- Describe the procedures for donning and doffing the respiratory protection devices and protective clothing used at the facility and/or industry involved.

- Understand the various environmental, mechanical, physiological and psychological stresses to which personnel working in chemical protective clothing are subjected.

- Identify the mechanisms by which heat builds up in workers operating in chemical protective clothing, and the appropriate measures to take for someone experiencing a heat related illness.

- Describe the various monitoring instruments used for air monitoring, including: a Combustible Gas Indicator, a Colorimetric tube, a Photo-ionization Device, an Oxygen Detection Device. A Multi-Detection Instrument reading Combustible gasses, Oxygen, Carbon Monoxide and Hydrogen Sulfide may also be used.

- Understand the hazards and risks involved with Confined Space Operations during a hazardous materials release.

- Describe the information needed to conduct a Hazard and Risk Assessment during a hazardous materials incident.

- Understand various offensive control options that may be utilized at a hazardous materials incident including repositioning leaking drums, overpacking, using absorbents, plugging, patching and catching. The student will describe the purpose of, procedures for, equipment required, and safety precautions appropriate for each method.

- Describe various defensive control options that may be utilized at a hazardous materials incident including damming, diking and diverting. The student will describe the purpose of, procedures for, equipment required and safety precautions appropriate for each method.

- Explain various decontamination methods, the types of decontamination, factors that can affect the decontamination process and resources needed to establish a Contamination Reduction Corridor. The student will also identify general guidelines for Emergency Decontamination, including sources for selecting appropriate decontamination procedures and solutions.

- Demonstrate the ability to perform one of the following functions at a simulated hazardous materials incident:

    1. Analyze the simulated hazardous materials incident to determine the problem and predict the outcome.
    2. Identify and perform the appropriate procedures required to manage the simulated incident.
    3. Utilize appropriate technical references to determine product identification and hazards, chemical protective clothing required, and appropriate tactical operations and decontamination procedures.
    4. Select and use proper chemical protective clothing and equipment.
    5. Develop and utilize a site safety plan.
    6. Develop and utilize an Incident Action Plan.
    7. Identify and perform appropriate decontamination procedures.
    8. Identify and use the appropriate tools and equipment necessary to mitigate the simulated problem.
    9. Identify and use the selected method for identification of the released hazardous material.
    10. Identify and use accepted standard operating procedures for hazardous materials incidents.

Session 2. Regulatory Overview For Hazardous Materials Technicians

Over the past 50 years, but mostly in the last 20 years, the federal government has passed many environmental and safety laws. Most have been directed at the protection of air, land, water and the industrial worker. Due to the shipyard's location and diverse production operations, nearly all environmental laws and occupational health and safety laws can effect shipyard operations. The environmental and safety laws and regulations determine what is required for compliance. Shipyards must stay in compliance with these laws and regulations in order to protect the environment and employee safety.

Laws Versus Regulations

A law is written by a legislative body (i.e., congress or senate). The law is frequently the result of an initiative raised by an interested group of citizens. A law is a specific or general statement of what is to be performed but not necessarily how it will be accomplished. Laws are generally written by persons who do not have the technical expertise about how to implement the requirements of the law. Therefore, enforceable "regulations" are written to describe the requirements of the law.

A regulation is a document detailing procedures for implementing, complying and enforcing the law. Regulations are generally written by the agency that is charged with implementing and/or enforcing the law (i.e., DOT, OSHA, EPA, etc.). Shipyard environmental and safety professionals frequently refer to regulations to identify how compliance is achieved and what is expected. Therefore, the regulation is what actually defines "regulatory compliance."

The following is a brief list of the Federal environmental and occupational health laws which have been passed throughout the years:

Year	Laws and Regulation
1955	**Clean Air Act (CAA)**
1965	**Solid Waste Disposal Act (SWDA)**
1969	**National Environmental Policy (NEPA)**
1970	**Resource Recovery Act (RRA)**
1970	**Occupational Safety and Health Act (OSHA)**
1972	**Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)**
1972	**Clean Water Act (CWA)**
1974	**Hazardous Materials Transportation Act (HMTA)**
1976	**Resource Conservation and Recovery Act (RCRA)**
1976	**Toxic Substances Control Act (TSCA)**
1977	**Clean Water Act (CWA)**
1980	**Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)** **Act to Prevent Pollution From Ships**
1986	**Superfund Amendments and Reauthorization Act (SARA)**
1990	**Pollution Prevention Act (PPA)** **Oil Pollution Prevention Act (OPA-90)** **Clean Air Act Amendments (CAAA)** **Occupational Health and Safety Act (OSHA) 1910.120 HAZWOPER**
1992	**Federal Facilities Compliance Act (FFCA)**

Several of the environmental laws are outlined below to provide a brief introduction:

Clean Air Act (CAA):
The Clean Air Act of 1970 was designed "to protect and enhance the quality of the Nation's air resources so as to promote public health and welfare...". In accordance with this Act, the Environmental Protection Agency (EPA) is required to monitor air emissions and issue permits to ensure that specific air standards are met. Amended in 1990, this Act is now significantly stronger and establishes specific goals and timetables for reducing air pollutants. Federal and State agencies are making a cooperative effort to reduce pollutants at their source. To achieve compliance, market incentives and increased fines have been incorporated into this Act which encourage industry to take a proactive approach to meet and exceed these standards

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA):
The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) authorizes the EPA to regulate the manufacture, distribution, importation, and use of pesticides. Broadly defined, a pesticide is any agent used to kill or control undesired insects, weeds, rodents, fungi, bacteria, or other organisms. The term "pesticides" includes insecticides, herbicides, rodenticides, fungicides, nematicides, acaricides, as well as disinfectants, fumigants, and plant growth regulators. FIFRA requires pesticide manufacturers to register all active ingredients of pesticide formulations. Many types of antifoulant coatings applied to the underwater hulls of ships are classified as pesticides, and subject to federal and/or state pesticide regulations.

Clean Water Act (CWA):
The Clean Water Act (CWA)of 1977, formally known as the Federal Water Pollution Control Act, authorizes the EPA to regulate the control and prevention of surface and ground water pollution. The CWA addresses the regulation of both domestic and industrial wastewater. The primary tool for the management of wastewater is the National Pollutant Discharge Elimination System (NPDES). NPDES permits are issued by the EPA unless the State in which the discharge is located has been given authority by the EPA to issue permits. Permits are required for industrial activities, as well as facilities treating domestic wastewater. NPDES permits usually contain limits on the quantities of specific pollutants which can be discharged from the permitted point source. They also regulate sampling, chemical analysis, and reporting requirements.

The major objective of the CWA is to restore and maintain the "chemical, physical and biological integrity of the nation's waters." The act seeks to secure water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and provides for the recreation in and on water. Progress toward this objective has required spending billions of dollars and controlling of hundreds of thousands of water pollution sources.

The act requires each state to set water quality standards for every significant body of surface water within its borders. Water quality standards represent the goals which pollution controls are meant to secure. To set these standards, states specify the uses of each body of water (such as drinking water, recreation, commercial fishing) and restrict pollution to levels that permit those uses.

Industries discharging pollutants into waterways, or publicly owned systems, are also subject to control requirements, with an ultimate goal of completely eliminating the discharge of pollutants into the nation's waters (i.e., “zero discharge’). Nationwide standards are established by EPA for certain categories of industries, with requirements tailored to the availability and economic feasibility of control technology. These effluent limitations have become increasingly stringent through the 1980's, particularly for discharges of toxic pollutants. Like municipal dischargers, industrial point source dischargers must secure permits under the NPDES program. Industries using public sewage systems must meet pretreatment standards designed to prevent the discharge of pollutants, particularly toxics, that adversely affect or simply pass through secondary treatment facilities.

Under the Act the EPA and the U.S. Army Corps of Engineers are jointly responsible for protecting waters against degradation and destruction caused by disposal of dredged spoils or fill. This protection extends to the nation's wetlands. Permits to carry out dredge, and fill activities, in wetlands are granted by the Corps of Engineers, subject to EPA approval. Due to the importance of wetlands as a natural resource, EPA has established an Office of Wetlands Protection to provide increased leadership and assistance in protecting this ecological asset.

Safe Drinking Water Act (SDWA):
The Safe Drinking Water Act (SDWA) authorizes the EPA to regulate drinking water. The EPA sets standards which must be met by all drinking water supplied to the public. The facility that supplies drinking water is responsible for ensuring that the water meets these standards. The drinking water program was established under the premise that the EPA would authorize the States to carry out and enforce the program. The requirements of the SDWA apply to all public water systems. A public water system is one which serves piped water to at least twenty-five people or fifteen service connections for at least sixty days of the year.

SDWA is intended to provide for the safety of drinking water supplies throughout the nation. This includes underground and above ground sources, by establishing and enforcing drinking water quality standards. In addition, the act requires the development of an underground injection control program to regulate the discharge of wastes into underground water supplies.

Hazardous Materials Transportation Act (HMTA):
The Hazardous Material Transportation Act (HMTA) of 1974 authorizes the Secretary of Transportation to protect the nation against the risks to life and property that are inherent in the transportation of hazardous materials in commerce. In accordance with this Act, the Department of Transportation (DOT) is authorized to issue regulations governing the safe transportation of hazardous materials in intrastate, interstate, and foreign commerce. The hazardous materials regulations include requirements for material classification, identification and packaging, transportation and handling, and incident reporting. In 1990, the Hazardous Material Uniform Safety Act of 1990 was enacted to require training and ensure safe handling of hazardous materials. This amendment to the HMTA established specific training requirements for employees who work with hazardous materials, and specified dates by which these training requirements must be satisfied.

National Environmental Policy Act (NEPA):
The National Environmental Policy Act (NEPA) requires federal agencies to consider the environmental impact of proposed actions in their planning and decisions. NEPA requires federal agencies to prepare detailed statements, termed Environmental Impact Reports for major federal actions, which will significantly affect the quality of the environment. Projects that could prompt NEPA review include large dredging projects, construction of major new installations, major land acquisitions, changed use of property, construction of new wharves and docks, and disposal of toxic substances.

NEPA made it the policy of the federal government, to use all practical means, to administer federal programs in the most environmentally sound manner. It ensures that every agency (Department of Defense, Department of Energy, Department of the Interior, etc.), will consider the environmental consequences of its actions before a project begins. Activities ranging from federal water projects to issuing a permit to a private party to operate on a federal facility must be carefully considered, before action is taken. NEPA requires procedures to ensure that environmental factors are taken into account in decision making.

NEPA established the President's Council on Environmental Quality and requires an annual report on the state of the environment. NEPA's most well known feature is the environmental impact statement (EIS), required of any federal agency proposing an action significantly affecting the quality of the human environment. Actions in which the impact is not known, or may not be significant, require an Environmental Assessment (EA). NEPA does not prevent an activity, but requires, through the EIS, that the agency determine and consider the environmental effects of the proposed action.

Solid Waste Disposal Act (SWDA):
The Solid Waste Disposal Act (SWDA) authorizes the EPA to regulate the management, treatment, storage, and disposal of solid wastes. Solid waste includes household, municipal, commercial, and industrial refuse and encompasses both hazardous and non-hazardous waste, including medical waste and can be in the form of a gas, liquid, or solid. The federal regulations under SWDA focus on non-hazardous wastes, commonly known as trash or garbage. The EPA regulates solid waste collection, storage, recycling, incineration, and land disposal. They requires mandatory procurement of certain recycled materials by federal government agencies. State and local authorities also regulate solid waste disposal.

Resource Conservation and Recovery Act (RCRA):
The Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendment Act (HSWA), authorizes the EPA to regulate the management, treatment, storage, and disposal of hazardous waste. Waste products are classified as hazardous if they exhibit the characteristics of ignitability, corrosivity, reactivity, or toxicity, or if they are listed as a hazardous waste in the regulations. The major intent of RCRA is to promote "cradle-to-grave" management of hazardous waste, to reduce the amount of hazardous waste generated, and to minimize the detrimental impacts of hazardous waste on the environment. RCRA and HSWA also established standards for the management of underground storage tanks, used oil, and land disposal restrictions, which encourage treatment in lieu of disposal.

Most of the regulations developed under RCRA concern the control of hazardous waste generators, transporters and treatment, storage and disposal (TSD) facilities. RCRA authorizes EPA to list materials as hazardous wastes and to develop record-keeping, labeling and handling requirements for these wastes. RCRA regulates hazardous wastes from their generation to their final disposal.

It is important to note that although RCRA creates a framework for the proper management of hazardous and non-hazardous solid waste, it does not address the problems of hazardous waste encountered at inactive or abandoned sites, or those resulting from spills that require emergency response. These situations are all covered under the Superfund Act (CERCLA), as discussed below.

Toxic Substances Control Act (TSCA):
The Toxic Substance Control Act of 1976 (TSCA) was enacted by Congress to test, regulate, and screen all chemicals produced or imported into the U.S. Most environmental regulations address problems associated with the management of hazardous substances after the substances have served their useful purpose (i.e., how do we dispose of the waste?). TSCA addresses substances which are in use, and in some cases, prohibits their manufacture or importation. A major intent of this Act is to prevent problems before they occur, rather than solve them at the "end of the pipeline". Manufacturers of new chemicals must provide the EPA with 90-day advance notification of their intent to manufacture, unless excluded by TSCA. Significant new uses for existing chemicals require the same notification. In addition to these general requirements, TSCA addresses specific hazardous chemical substances: polychlorinated biphenyls (PCBs), which are commonly used as dielectric fluids

in transformers and capacitors; asbestos, which is used in applications requiring heat resistant material; chlorofluorocarbons (CFCs) used as refrigerants; certain metalworking fluids; certain water treatment chemicals; dioxins; and furans.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA):
In response to increased public concern over the dumping of chemical wastes, Congress passed the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) in 1980. This Act established a $1.6 billion dollar fund for cleaning up old waste spill and storage sites. The purpose of this fund was to expedite the remediation of our nation's worst waste sites, while seeking compensation through litigation from the persons responsible. While CERCLA lacked adequate funding and legal strength, it established the groundwork for determining legal liability for all those who "caused or contributed to a release of hazardous wastes."

Known as the Superfund, CERCLA established a tax on certain chemical feedstocks that are used to fund the cleanup of abandoned hazardous waste dump sites throughout the country. Superfund is designed to provide immediate, remedial action for highly contaminated areas. The government can then seek to recover these cleanup costs from responsible parties after the health risk has been eliminated.

Superfund Amendments and Reauthorization Act (SARA):
It became apparent in 1985 that the original funding for cleaning up waste sites, authorized under CERCLA, was inadequate. Although 14 sites had been cleaned up, the National Priority List of sites in need of remediation continued to grow. The Superfund Amendments and Reauthorization Act (SARA) of 1986 contributed $8.5 billion to the fund. SARA established the Defense Environmental Restoration Account (DERA) to fund the clean-up of Department of Defense waste sites. Title III of this Act established specific reporting and planning requirements for businesses that handle, store, or manufacture hazardous materials. Among these requirements are specific methods for reporting incidental leaks and spills, planning for emergency response, and monitoring ongoing releases. In 1991, a reauthorization approved an additional $1.8 billion per year to the fund through 1994.

The amendments require the EPA to select clean-up actions that use "permanent solutions" and provide for on-site treatment, or resource recovery, to the maximum extent practicable. In doing so, the statute clearly establishes a preference for clean-ups which permanently and significantly reduce the volume, toxicity or mobility of wastes. Off site transport and re-disposal is to be considered the least favored option, where practicable treatment technologies are available. The law contains extensive language concerning compliance with other laws and standards. In general, no federal, state, or local permits are required for remedial actions conducted entirely on-site. However, if contaminants will remain on-site, the clean-up must attain standards and criteria of federal and state laws if these standards are legally applicable, or relevant and appropriate, under the circumstances of the release. Federal requirements to be considered include those established under TSCA, SDWA, CAA, and RCRA. The Act addresses "emergency planning and community right to know" issues and requires commercial users of "hazardous materials" to report types and quantities to local authorities as discussed below.

Emergency Planning and Community Right to Know Act (EPCRA):
The Emergency Planning and Community Right to Know Act of 1986 (EPCRA), also known as SARA Title III, requires immediate notification of state and local authorities in the event of a release of a hazardous material. Congress enacted this law to help local communities protect public health, safety, and the environment from chemical hazards. EPCRA is designed to "provide a basis for each community to develop a chemical release preparedness and planning program that suits its individual

needs" and to "provide the public with the identity, quantity, location and properties of hazardous substances in the community." By establishing emergency planning and notification requirements as well as hazardous substance notification procedures, EPCRA is designed to increase community awareness and minimize the effects of authorized and incidental releases.

Act to Prevent Pollution from Ships:
The Act to Prevent Pollution from Ships was enacted in 1980 to implement the agreements made at the Protocol of 1978, and the International Conference for the Prevention of Pollution from Ships of 1973. Both conventions were held in London to discuss local and international laws governing the discharge of oil and oily waste from marine vessels. In accordance with this Act, new ships must be designed to reduce the chance of oil spills and eliminate the discharge of oily waste during operation. Specific reporting of solid waste discharges and ballast releases were established, as well as specific operations, inspection, and certification requirements. This Act also requires that heads of certain federal departments prescribe standards for ships under their authority, which are reasonable and practicable, without impairing the operations or operational capabilities of such ships.

Pollution Prevention Act (PPA):
The Pollution Prevention Act (PPA) of 1990 established that it was the national policy of the United States to prevent and reduce pollution at the source, whenever feasible. Pollution which cannot be prevented should be recycled. That which cannot be recycled or prevented should be treated and disposed of in an environmentally sound manner. The PPA encourages source reduction of all types of waste, not just hazardous wastes. In accordance with this Act, the EPA has established an office to promote pollution prevention and assist businesses in adopting pollution prevention techniques. The EPA must consider the impact of new projects on source reduction efforts. Facilities that are currently required to file annual toxic chemical release inventories must now include information on the their toxic chemical source reduction and recycling efforts.

Oil Pollution Act. (OPA-90):
In 1990, Congress passed the Oil Pollution Act to expand the scope of oil pollution prevention, and response activities to all oil discharge facilities, which pose a potential harm to navigable waters. This Act amended the Clean Water Act to augment federal authority, increase fines, and emphasize preparedness and prevention. It increased the number of regulated activities by including both transportation, and non-transportation, related facilities in close proximity to water sources. In accordance with this Act, the EPA required that all "substantial harm facilities" submit a local response plan for approval by February 18, 1993 or stop handling, storing, or transporting oil. This Act also provided specific guidance on how to develop response plans.

Federal Facilities Compliance:
The Federal Facilities Compliance Act of 1992 was designed to amend the Solid Waste Disposal Act so as to waive the sovereign immunity of federal agencies. This legislation requires federal facilities to comply with all Federal, state and local hazardous waste management requirements. In accordance with this Act, federal agencies have the responsibility to take a leading role in reducing pollution and informing the public of toxic and hazardous chemicals at federal facilities. Federal agencies are no longer exempt from the fines and penalties that the EPA and states use to enforce compliance with hazardous waste laws with respect to non-governmental facilities (i.e., privately owed shipyards). Specifically, the head of each federal agency must perform an initial assessment of toxic releases and develop a plan to achieve compliance with the Pollution Prevention Act and EPCRA. Starting in 1995, federal agencies will begin submitting progress reports to the EPA. The goal of this Act is to protect human health and the environment by making the federal government accountable for its environmental record.

Regulatory Agencies

Environmental Protection Agency (EPA)

The U.S. Environmental Protection Agency (EPA) is a federal agency with environmental protection regulatory and enforcement authority. They administer the Clean Air Act, the Clean Water Act, the Resource Conservation and Recovery Act (RCRA), the Toxic Substances Control Act (TSCA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, or Superfund) and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

Occupational Health and Safety Administration (OSHA)

The Occupational Health and Safety Administration (OSHA) is under the Department of Labor. It was created as a result of the Williams - Steiger Act, which was passed by Congress in 1969 and became effective in 1970. Its charter is to provide a safe and healthy work-place for all workers. Since its establishment, OSHA has written a variety of work place safety standards, and it has hired safety inspectors, industrial hygiene inspectors, and consultants to enforce those regulations. Some states that wish to have more local control, have passed their own laws, while other states let OSHA handle all regulatory action. If OSHA puts out a new standard, the states with their own plans must adopt that standard. They can be more strict, but not less strict. OSHA is the author agency of the Hazardous Waste and Emergency Response Operations Standard that constitutes the framework of this course.

The purpose of OSHA is "to assure, so far as possible, every working man and woman in the nation safe and healthful working conditions." To achieve this goal, the act authorizes the development of handling and labeling requirements and safety precautions (such as protective clothing or equipment). It also requires employee health record-keeping and the development, and enforcement, of maximum contaminant levels for toxins in work place air.

National Institute for Occupational Safety and Health (NIOSH)

The National Institute for Occupational Safety and Health (NIOSH) is a federal agency, but it does not act in a regulatory capacity. It is primarily a testing and research organization established by the OSHA Act. NIOSH conducts studies and recommends standards to OSHA. Originally, the institute also tested and certified all safety equipment and respirators. NIOSH still approves respirators but has turned safety equipment testing over to the Safety Equipment Institute, an industry group.

Department of Transportation (DOT)

The Department of Transportation (DOT) is responsible for, among other things, implementation and management of regulations outlined in 49 CFR. The regulations are applicable to the transportation of hazardous materials, chemicals, wastes and substances. The DOT regulations are also referenced in the OSHA 1910.120 standard and must also be included within training programs. Therefore, the DOT sets and enforces standards for hauling hazardous materials by water, road, rail, or air. These standards include packaging, marking and transportation of hazardous materials and wastes.

United States Coast Guard (USCG)

The Coast Guard is a division of the Department of Transportation and is responsible for monitoring the nation's waterways. This effort includes cargo shipment regulation and inspection, and pollution control and cleanup activities. The Coast Guard also has a "Memorandum of Understanding" with the EPA which assigns the Coast Guard support activities at Superfund sites. The Coast Guard assists the EPA with record keeping, cleanup activities and health and safety of many hazardous waste sites.

Session 3. Hazardous Materials Information and Reference Sources

Emergency response personnel can be faced with hazardous materials problems on a daily basis. The safe outcome of these incidents is directly related to the shipyard responders ability to get accurate information. The key to success is knowing:

- what information is needed,
- where to get the information, and
- how to properly interpret and utilize the information.

The Hazardous Materials Industry Technician must gain a working knowledge of the chemicals used at their facility in order to provide adequate response. This knowledge will enhance their ability make sound decisions on protective actions, control zones, levels of protective clothing and other tactical operations during a release. There are many sources of information on chemicals available to hazardous materials responders. The key is to determine which resources will provide useful information. To be useful, information must be easy to access, accurate, and understandable. Information can be obtained from several sources including technical personnel at the facility, books, and computer data bases.

Personnel at the facility can be a valuable source of information. Many times workers can pass on information as to what happened, what materials are involved and what the conditions are. Chemists and other technical experts on scene can provide useful technical information. Technical assistance can also be obtained from industry experts.

Remember that although on-site personnel can give good information about a substance, they seldom work with it in an emergency situation. They may not consider the incident to be as hazardous as it is. Always be aware of the "no big deal" syndrome that on-site personnel can sometimes have. All incidents must be treated as a big deal. If information provided is inaccurate or out-of-date, the potential for injury can be great. Always confirm information given by technical experts with at least two other information sources.

Hazardous Materials Reference Books / Technical Publications

Books are a good source of hazardous materials information. Books are laid out in many different formats. To be able to access information quickly, response personnel must be properly trained. To maintain proficiency in using reference books requires continuous practice.

A reference library on hazardous materials response vehicles should be maintained. Be aware that early editions often have errors and some sources may become outdated. Information is constantly changing as more is learned about existing chemicals, and as new chemical compounds are created. For this reason, most reference books are updated on a regular basis. Use at least three sources of information to get an accurate profile of the chemical during an emergency. Remember that not every source contains all of the desired information. Keep the Hazardous Materials Technician library books updated and use the most recently published books.

Most hazardous materials reference books have their own area of emphasis. As an example, there are several books available that address the reactivity of chemicals. Responders should consult these references when confronted with the potential mixture of chemicals. Some books are divided into several sections covering different aspects of hazardous materials. Response personnel must become familiar with the various reference books in their library and know which book will be the best source of a specific type of information. This discusses in detail three of the sources of

information including: the DOT North American Emergency Response Guide, the NIOSH pocket guide, and the MSDS. Other information sources will also be discussed, although in less detail.

Background & Purpose of the North American Emergency Response Guidebook (NAERG96)

The 1996 North American Emergency Response Guidebook (NAERG96) was developed jointly by Transport Canada (TC), the U.S. Department of Transportation (DOT), and the Secretariat of Communications and Transportation of Mexico (SCT) for use by fire fighters, police, workers, and other emergency services personnel who may be the first to arrive at the scene of a incident involving hazardous substances. It is primarily a guide to aid first responders in quickly identifying the specific or generic hazards of the materials involved in the incident, with the priority of protecting themselves, and the general public, during an initial response.

The guidebook will assist responders in making initial decisions upon arriving at the scene of a hazardous substance incident. It should not be considered a substitute for emergency response training, knowledge or sound judgment. The NAERG96 does not address all possible circumstances that may be associated with a hazardous substance incident. It is primarily designed for use at a hazardous substance incident occurring on a highway or railroad. Be aware that there may be limited value in its application at shipyard locations.

The NAERG96 is a basic safety tool for identification and response information that recognized as good practice standards for Hazardous Materials Technicians during initial actions. The NAERG96 has five colored border pages:

1. **White -** Basic information and instructions (Placard Tables)
2. **Blue -** Material name, guide number, and four digit number An alphabetical listing of more than three-thousand (3,000) hazardous materials. If the material is high-lighted it will be listed in the green-bordered pages.
3. **Yellow -** Four digit number, guide number, and material name: A numerical list of the same items by their four-digit United Nations identification number. If the material is high-lighted it will be listed in the green-bordered pages.
4. **Orange -** Guide number pages: Materials listed in the yellow pages and blue pages are grouped according to their expected chemical behavior during a spill or fire, with a generalized hazard and action guide included for each group. The guides can be read quickly, and give important facts regarding fire and explosion hazards, health hazards and emergency actions recommended for small and large fires, small or large spills and first aid treatment of exposure victims. The major hazard of the group will be listed first: i.e., if "Health" is the materials primary hazard it will be listed first
5. **Green -** Table of isolation and protective actions: This table "suggests distances useful to protect people from spill areas involving hazardous materials that produce poisonous effects when inhaled." There are different ratios for day and night, night distances being as much as five times as far as day distance.

The Guide Number Pages (Orange)

Each orange-bordered, numbered guide, provides essential guidance in a form designed for first responders with limited hazardous substances training. A numbered guide is assigned to each material listed in the indexes. Neither the order in which the guides are presented nor the guide number itself is of any significance. Since many materials represent similar types of hazards that call for similar initial emergency response actions, only a limited number of guides are required. The orange-bordered guides are not applicable when materials of different classes and/or divisions are involved in an incident and are intermingled. Incidents involving more than one class of material

require the incident commander to obtain informed advice as soon as the scope of the incident can be determined. Materials involved in an incident may, by themselves, be non-hazardous; however, a combination of several materials, or the involvement of a single material in a fire, may still produce serious health, fire or explosion hazards.
First responders at the scene of a hazardous substances incident, should seek additional specific information about the hazardous substance in question as soon as possible. The information received by contacting the appropriate emergency response agency may be more specific and accurate than the NAERG96 information. The following itemized list provides information sources that may be vital in identifying a hazardous substance:

1. MSDS (Material Safety Data Sheets for a chemical)
2. Placards and Labels (colors and symbols)
3. Shipping Papers (Bill of Lading, Way Bill, Etc.)
4. Reference Guides (North American Emergency Response Guidebook 1996)
5. Technical Information Centers (CHEMTREC)
6. NFPA 704 Labeling System
7. Computer data bases (CAMEO and HIT, etc.)
8. UN or NA number, (United Nations or North American 4 digit number)
9. Chemical CAS number (Chemical Abstract Services number)

BECOME FAMILIAR WITH THE NAERG96 BEFORE USING IT DURING AN EMERGENCY!

HOW TO USE THE GUIDES EFFECTIVELY

In the U.S., according to the requirements of OSHA and EPA, first responders must be trained regarding the use of the NAERG96. The titles of the orange guide pages identify the general hazards of the hazardous substances covered. The process for using the guide is presented below:

1.) Identify the Material (Find one of the following):

- The 4-digit ID number on a placard or orange panel
- The 4-digit ID number on a shipping paper or MSDS
- The Name of the material on a shipping paper, MSDS, or the package. If an ID number or the material name cannot be identified and the placard can be seen, use the hazard table to determine the Guide number.

2) Look up the 3 digit Guide number for the materials

- The ID number index (Yellow Bordered Pages)
- The Name of the Material Index (Blue Bordered Pages)

Note: The letter "P" following the guide number in the yellow-bordered and blue-bordered pages identifies those materials which present a polymerization hazard under certain conditions. For example, Acrolein, inhibited, Guide 131 P. Also, if the material is highlighted in either index, look-up he material in the Table of Initial Isolation and Protection Action Distances (Green Bordered Pages).

3) Turn to the Guide Pages (Orange Bordered Pages) and Read Carefully!
Each guide is divided into three main sections:

Section 1 Potential Hazards - Describes potential hazards that the material may display in terms of fire/explosion and health effects upon exposure. The emergency responder should consult this section first since it indicates in very brief form the dangers the material that may present. This allows the responder to make decisions regarding the protection of the emergency response team as well as the surrounding population.

Section 2 Public Safety - Outlines suggested public safety measures based on the situation at hand. It provides general information regarding immediate isolation of the incident site, the recommended type of protective clothing and respiratory protection. Suggested evacuation distances are listed for small and large spills, and for fire situations.

Section 3 Emergency Response - Covers emergency response actions and first aid. It outlines special precautions for incidents which involve fire, spill or chemical exposure. Several recommendations are listed under each part, which will further assistance in decision making.

The information on first aid is general guidance prior to seeking medical care. It is difficult to be specific about the kind of medical assistance that should be sought. Factors for consideration will include, 1) the extent of the exposure, 2) the material involved, 3) the nature and severity of the injuries, and 4) the proximity to emergency and medical services. When human exposure has occurred, immediate efforts should be made to remove all contaminated clothing and shoes and to obtain medical assistance in evaluating the injuries and need for hospitalization.

Note: NAERG96 incorporates hazardous substances lists from the most recent United Nations Recommendations as well as from other international and national regulations. Explosives are not listed individually by either proper shipping name or ID Number. They do, however, appear under the general heading "Explosives" on the first page of the ID Number index (Yellow-Bordered Pages) and alphabetically in the Name of Material index (Blue-Bordered Pages).

Hazard Classes

The “hazard class” of any particular hazardous material is indicated by its class or division number and its class name. The hazard class or division is required on the shipping paper and it is also used to determine placarding, marking and other labeling requirements. The following table describes the hazard classes, their placard color and the NAERG96 Guide number.

Class/Division	Division Name	Placard Color	Guide # s
1.1	Explosives (mass explosion hazard)	Orange	112
1.2	Explosives (projection hazard)	Orange	112
1.3	Explosives (predominantly a fire hazard)	Orange	112
1.4	Explosives (no significant blast hazard)	Orange	114
1.5	Very Insensitive Explosives; Blasting Agents	Orange	112
2.1	Flammable Gas	Red	118
2.2	Non-Flammable Compressed Gas	Green	121
2.3	Poisonous Gas	White	123
3.0	Flammable & Combustible Liquid	Red	127 / 128
4.1	Flammable Solid	Red/White Stripes	134
4.2	Spontaneously Combustible Material	White/Red Half/Half	136
4.3	Dangerous When Wet Material	Blue	139
5.1	Oxidizer	Yellow	143
5.2	Organic Peroxide	Yellow	148
6.1	Poisonous Materials	White	153
6.2	Infectious Substance (Etiologic Agent)	White	158
7.0	Radioactive Material	White/Yellow	163
8.0	Corrosive Material	White/Black	153
9.0	Miscellaneous Hazardous Materials	White/Black Striped	171

NIOSH Pocket Guide

Another commonly used resource book is the NIOSH Pocket Guide. This book lists the PELs, IDLH concentrations and effects on target organs for all materials included in the manual. It also lists ionizing potentials, which is useful if you are using a photoionization detection device. It is a reference for industrial hygiene and medical personnel. The pocket-guide has been developed to provide chemical specific data, to supplement general industrial hygiene knowledge. Abbreviations and codes have been used extensively to maximize the amount of data provided in a limited space.

Explanations are provided to the reader in the front of the guide describing how to interpret these symbols and abbreviations. These abbreviations and codes have been designed to permit rapid comprehension by the user. The guide is organized into columns. A brief discussion of the information located in each column follows:

Column	Description of Contents
Column I.	**Chemical Name, Structure/Formula, CAS and RTECS number s., and DOT ID and Guide number s:** Chemicals are listed alphabetically in Column 1.
Column II.	**Synonyms, Trade Names and Conversion Factors:** Table shows other names "synonyms" by which a chemical is known.
Column III.	**Exposure Limits (TWA unless noted otherwise):** - The NIOSH PELs are listed first in this column. - OSHA PELs are listed next. - ACGIH TLVs are listed when they are more <u>restrictive</u> than NIOSH REL or OSHA PEL.
Column IV.	**IDLH Level:** Column IV indicates concentrations of the chemical in the air that are considered to be immediately dangerous to life and health (IDLH), and should never be inhaled. The notation "Ca" is listed in this column for some chemicals. This designates a cancer causing agent (carcinogen), and suggests that no exposure above the PEL should be permitted, even though immediate death would not result. In fact, some scientists argue that there is no "permissible" safe exposure level to a carcinogen. So for carcinogens, the IDLH levels are listed in brackets, indicating that they are thought to be hazardous at any level of exposure.
Column V.	**Physical Description:** Column V provides a brief description of the appearance and odor of the substance. These descriptors can be used as clues for early identification (or confirmation after identification). Purposely sniffing a chemical to determine its odor should be avoided. The detectable odor level may be higher than the safe breathing level.
Column VI.	**Chemical and Physical Properties:** These are the same chemical and physical properties listed in the Material Safety Data Sheet.
Column VII.	**Incompatibilities and Reactives:** Materials with which the chemical being researched may react are listed in column VII. The chemical should never be mixed with, or be allowed to come in contact with, any material listed in this column. The resulting chemical reaction could lead to fire, explosion, or generation of a toxic gas or vapor. For example, acetaldehyde, when allowed to be in prolonged contact with air may cause formation of peroxides that may explode and burst containers. This column is of special importance to the emergency responders, who are likely to encounter the product outside of its container.
Column VIII.	**Measurement Method:** Column VIII provides information on suggested sampling and analysis methods used to determine the atmospheric concentration of the chemical in the work area. The abbreviations are listed in Table 1 near the front of the guide.
Column IX.	**Personal Protection and Sanitation:** Column IX provides recommendations for preventing or maximizing exposure to the chemical being researched. Translations of the terms and abbreviations are listed in Table 3 near the front of the guide.
Column X.	**Recommendations for Respirator Selection:** Column X provides information regarding respiratory protection. The agency recommending respiratory protection is identified at the top of the column. The abbreviations used are explained in Table 4 near the front of the guide.
Column XI - XIV.	**Health Hazards:** Columns XI through XIV provide information on potential adverse health effects resulting from chemical exposure. **Route of Entry.** Column XI lists the routes of entry by which chemicals may enter the body. Abbreviations used in this column refer to: Inhalation (breathing in), Ingestion (swallowing), Con: Contact (with skin or eyes), Abs: Absorption

	(through the skin into the blood vessels and into internal body tissues and organs). **Symptoms:** Symptoms that may result from chemical exposure are listed in column XII. Table 5 in front of the NIOSH Guide explains the abbreviations used in this column. **First Aid:** Actions which should be taken immediately following accidental exposure to chemicals are described in column XIII. The abbreviations used in this column are explained in Table 6 of the Guide. **Target Organs:** Column XIV lists the organs of the body most likely to be affected by chemical exposure. The abbreviations are explained in Table 5 of the Guide.

Material Safety Data Sheet (MSDS)

The Material Safety Data Sheet (MSDS) is a document which supplies information about a particular hazardous substance or mixture. Employers must obtain and make available to employees an MSDS for each of the hazardous substances they may use and be exposed to in the workplace. The MSDS is another excellent resource for hazardous materials information. It gives the chemical name, along with the manufacturers address and phone number so additional information can be accessed. An MSDS must follow the standard format as specified in Title 8. The following sections must be included:

MSDS SECTION	OUTLINED INFORMATION
SECTION I - MANUFACTURER / PRODUCT IDENTIFICATION	Product name, address of manufacturer, importer or other party responsible for preparing the MSDS, emergency and non-emergency telephone number, date prepared or last changed
SECTION II - HAZARDOUS INGREDIENTS/ IDENTITY INFORMATION	Hazardous chemical names, Chemical identity, CAS number, concentration (%), OSHA PEL limits in air, ACGIH TLV limits in air
SECTION III - PHYSICAL/CHEMICAL PROPERTIES	Vapor density, melting point or range, specific gravity, boiling point or range, solubility in water, appearance and odor, warning properties
SECTION IV - FIRE AND EXPLOSION HAZARD DATA	Flash point, autoignition temperature, lower explosive limit (LEL), upper explosive limit (UEL), special fire fighting procedures, fire extinguishing materials, unusual fire and explosion hazards
SECTION V - HEALTH HAZARD INFORMATION	Symptoms of overexposure for each route of exposure, how to recognize exposure, acute and chronic effects of exposure, First Aid emergency Procedures for exposure, Suspected carcinogens (yes or no), medical conditions aggravated by exposure
SECTION VI - REACTIVITY DATA	Product stability, Conditions to avoid, Materials to avoid, Hazardous decomposition, Hazardous polymerization
SECTION VII - SPILL LEAK AND DISPOSAL INFORMATION	Spill response procedures, proper disposal of spilled wastes
SECTION VIII - PRECAUTIONS FOR SAFE HANDLING AND USE	Ventilation and engineering controls, respiratory protection, eye protection, clothing and equipment, hand protection (gloves), good work practices, decontamination of equipment, handling and storage requirements
SECTION XI - LABELING	DOT shipping name, precautionary statements, NFPA hazard rating

MSDS Note: If a section is left blank on an MSDS, it should not be assumed that the section is not applicable or innocuous. It Is more likely that there is not sufficient data on that subject or the hazard is unknown. Although the MSDS is an excellent resource for information, you should always compare the information with at least two other resources.

Books, Manuals, and References Concerning Chemicals and Emergency Response

There are many sources of information and response organizations that can provide technical data and physical assistance during hazardous materials incidents. These information sources provide

technical input regarding hazards associated with a spill, and methods to mitigate the problem. The different levels of information that may be required include site information, meteorology, physical/chemical properties of the hazard, applicable treatment methods, and the available cleanup resources.

When using sources of information, it is advisable to cross-check references. Always obtain concurring data from at least two sources, and try to use the most current edition of any reference, especially when searching for hygienic standards or toxicological data. The table below briefly describes some other sources available to emergency responders:

Source of Information	Description
Documentation of the Threshold Limit Values (TLV), ACGIH Publications Office	This reference includes pertinent scientific information regarding each substance, with references to literature sources used to determine each TLV. Each documentation also defines the type of toxic response for which the limit is used. This book should be consulted for a better understanding of TLVs.
NIOSH/OSHA Pocket Guide to Chemical Hazards, U.S. Government Printing Office	Information in this pocket guide comes from the *NIOSH/OSHA Occupational Health Guidelines.* Presented in a tabular format, it is a reference for industrial hygiene and medical surveillance practices. Included are chemical names and synonyms, permissible exposure limits, chemical and physical properties, signs and symptoms of overexposure, environmental and medical monitoring procedures, recommended respiratory and personal protective equipment, and procedures for treatment.
NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards, U.S. Government Printing Office	This three-volume document provides technical data for most of the substances listed in the *NIOSH/OSHA Pocket Guide.* The information is much more detailed and is designed primarily for use by industrial hygienists and medical surveillance personnel. In addition to the information found in the *Pocket Guide, Occupational Health Guidelines* includes recommended medical surveillance practices, air monitoring and measurement procedures, personnel sanitation, and spill and disposal techniques.
CHRIS (Chemical Hazards Response Information System), U. S. Government Printing Office	Contains detailed chemical, physical and toxicological information for over 3,500 substances. Information is presented in a concise, one-page format for ease-of-use by emergency responders.
Fire Prevention Guide on Hazardous Materials, National Fire Protection Association (NFPA)	The NFPA has combined five manuals into one comprehensive guide on hazardous materials. It discusses: 1. Flash point of oils, together with more than 8,800 trade name chemicals, their flash points, manufacturers, and principal uses. The flammability hazard can be determined from this information. 2. Fire hazards of 1,300 flammable liquids, gases, and solids, listed in alphabetical order with appropriate fire fighting information. Various properties listed include flash point, specific gravity, water solubility, hazard identification, and boiling point. 3. Toxicity data on 416 chemicals. 4. Hazardous reactions of over 3,550 chemicals. Reactions may involve two or more chemicals and cause fires, explosions, or other problems. A chemical is listed, followed by those chemicals which can cause a hazardous reaction. 5. Recommended system for identification of fire hazards of materials.
Guidelines for Selection of Chemical Protective Clothing. ACGIH Publications Office	Two volume set providing information on selection and use of chemical protective clothing. Includes detailed discussion of testing methods and results.
The Merck Index, Merck and Co.	*The Merck Index* is a comprehensive, interdisciplinary encyclopedia of chemicals, drugs, and biological substances. It describes 9,856 chemicals in a structured format. An extensive index and cross-index make the manual easy to use. For response personnel, it provides information on physical and chemical properties of materials and their toxicity.

Dangerous Properties of Industrial Materials, Irving Sax, Van Nostr and Reinhold Company	This book provides a single source of concise information on the hazards of nearly 13,000 common industrial and laboratory materials. Descriptive information and technical data are given in the three sections of the book. The main section, "General Information," is designed to expedite retrieval of hazard information. The three sections are: 1. General Information: synonyms, description, formula, physical constants 2. Hazard Analysis: toxicity, fire hazard, explosive hazard 3. Countermeasures: handling, storage, shipping, first aid, fire fighting, personnel protection
The Condensed Chemical Dictionary, Gessner G. Hawley, Van Nostrand Reinhold Company	This book, contains technical data and descriptive information covering many thousands of chemicals and reactions. It is designed for use in industrial situations, and can be helpful in assessing a hazardous waste site or spill. However, information pertaining to environmental behavior of chemicals is limited and can be misleading. Three distinct types of information are presented: 1. Technical descriptions of compounds, raw materials, and processes. 2. Expanded definitions of chemical entities, phenomena, and terminology. 3. Description or identification of a wide range of trade name products used in the chemical industry.
Registry of Toxic Effects of Chemical Substances, U.S. Printing Office	This annual publication is sponsored by NIOSH and contains toxic dose data with references to source documents and major standards and regulations for 35,000 chemicals.

Telephone Information Services

CHEMTREC and CHEM-TEL, INC. maintain a current list of state and Federal radiation authorities who provide information and technical assistance on handling incidents involving radioactive materials. The emergency response information services (CHEMTREC and CHEM-TEL) have requested to be listed as providers and have agreed to provide emergency response information to all callers. The phone number’s are:

CHEMTREC, a service of the Chemical Manufacturers Association
(24 hours) 1-800-424-9300 (Toll-free in the U.S. and Canada)

CHEM-TEL, INC., an emergency response communication service
(24 hours) 1-800-255-3924 (Toll-free in the U.S. and Canada)

Data Bases

There are many hazardous materials data bases that are available for use. However, response teams may need special communication systems such as a computer, fax machine or even a portable cell phone, in order to access them. Consulting on-line systems can greatly increase the available knowledge of the substance and aid in the decision-making process.

Two on-line systems are **Hazardline** and **CHEMTREC's Hazard Information Transmission (HIT)**. Hazardline is an on-line data base that is updated daily. It has over 90,000 listings. It costs $30/month, plus $2/minute to access the information available. CHEMTREC's HIT is also an on-line system. It requires pre-registration with CHEMTREC and is free to response organizations.

With technical advances in hardware and software, computers are rapidly replacing books as the primary source of information for many hazardous materials response teams. Computers are getting

smaller, faster, less expensive, and have more storage capacity than in the past. Computer data bases are easy and inexpensive to update.

One computer can easily store information equal to a complete reference library. However, they can present problems. Computers can and do break down. Some team members may not be proficient in the use of computers. It is still necessary to maintain a well-stocked reference library as a back-up should the computer fail. It is also necessary to keep reference books to cross reference the information provided by the data base.

There are several software packages in use. TOMES is available on CD-ROM and allows access to over 4,000 chemicals. It has an annual fee and is very comprehensive with regard to toxicology and exposure data.. CAMEO is another sophisticated computer program for the mitigation of hazardous materials incidents. CAMEO is written for use on Apple Macintosh or MS/DOS. It is compiled by NOAA and is available to response agencies for a nominal fee through the National Safety Council. CAMEO has 3,300 chemical names with their synonyms profiled.

Session 4. Shipyard Emergency Response and Site Safety Planning

A good planning process provides positive response outcomes. General Marshall, an exemplary planner in post World War II once said, "The plan is nothing, to plan is everything." Some say that General Marshall meant the completed plan pales in significance when compared to the time, energy, effort and attention to detail required to create the plan. Planning is a team process rather than an end result. It can be said that a good team planning process provides for good response outcomes. Knowing this, it could be said that the implementation of the plan elements, such as training, plan modification, inspections and procedure development, is of equal importance.

Two Types of Emergency Response Plans: (Pre-Event and Event-Specific)

There are essentially two types of hazardous substance emergency planning required by state and federal laws. The two types of plans are very important for an efficient and safe response to hazardous substance emergencies. The two types of plans include the Pre-Event Plans (shipyard facility specific) and Event-Specific Plans (pertain to a specific emergency response). Pre-event emergency plans can take several months to develop and are an excellent tool if developed properly. On the other hand, in developing event-specific plans, time is of the essence and an efficient process is essential.

1) Pre-Event Plans:

- Emergency Action Plans - Many states require the employer to develop an emergency action plan to protect employees in the event of a release of hazardous materials and/or fire. These action plans usually contain evacuation routes, major emergency procedures and community involvement.
- Emergency Response Plans - Developed and implemented to handle anticipated emergencies. These plans may be required if employees are expected to respond as a team. These plans can include Hazardous Materials Business Plans, Spill Prevention Control and Countermeasure Plans (SPCC), Adverse Weather Plans, Vessel Spill Response Plans and a variety of other plans that may be required by local state and federal regulations.

2) Event-Specific Plans:

- Incident Action Plans - Must be implemented during the emergency within the capabilities of available personnel and equipment. The plan is broad based and a strategic tool for managing the emergency and achieving desired results. It generally defines the problems involved and accesses the resources available to solve the problem. This plan is global, in that it involves a variety of hazards including potential environmental releases. This plan should be in writing if the incident is very large. Otherwise it may be incorporated into the site safety plan.
- Site Safety Plans - A tactical plan for all activities conducted in the control zones (especially the Exclusion Zone). It is developed to ensure the health and safety of all personnel involved in response activities at the site. It must be in writing, identifying all known and suspected hazards and communicated to all personnel prior the commencement of response activities in the control zones. The development of the site safety plan is performed by the Incident Commander with assistance from HazMat Technicians.

Event-Specific Planning Forms are provided at the end of this session.
Note: Event-specific planning procedures and processes are usually outlined in the Pre-event emergency response plans.

Benefits of Good Planning (Pre-Event and Event Specific)

Good planning places responders in a proactive rather than a reactive response mode. A reactive response mode will be unorganized and may result in miscommunication and injury to employees and responders and cause pollution of the environment. The following table shows the specific benefits of planning.

Benefits	Description
Proactive Response	Reduces the time spent reacting to the crisis and makes better use of time which prevents an increased crisis situation.
Incident Prevention and Hazard Analysis	The hazard analysis is a process that identifies hazards and evaluates risks, thereby reducing risks by eliminating or reducing conditions, which may cause an incident. This is done by making positive changes to facilities and processes during the planning stage. The goal is to eliminate the unknowns and institute "In-Control" management.
Encourages Involvement	Pre-Event planning will include personnel from several shipyard departments as well as support contractors or agencies that may respond to an emergency. The results are buy-in for the plan from company personnel and establishing a positive relationship with the local and state agencies. Event-Specific planning will also utilize input from the response team, where buy-in and agreement on objectives and safety are very important.
Identifies Proper Contingency Assessment	Planning will ensure proper evaluation of personnel, equipment and training needs. The plan should consider the responders level of training, resources and capabilities and their ability to adequately respond to a shipyard emergency. These issues are very important for both types of planning.
Identifies Incident Management	Planning will ensure that the incident will be managed properly. Individuals must be ready to take on their roles and responsibilities. Good management personnel and systems are important to the successful conclusion of any incident.

HazMat Technicians Must Know The Shipyard Emergency Response Plan

The HazMat Technician must know and understand their role in the shipyards emergency response plan. The plan will include several sections that describe specific and general responsibilities. Specific response plans should be explained and presented to all people who will be involved in an emergency response. It is the responsibility of the HazMat Technician to understand the following:

- General contents of the company's local emergency response plan
- Individual role in an emergency response
- Individual responsibilities specified in the plan
- Standard operating procedures for their role in the response

Emergency Response Planning Content

OSHA requires all shipyards that are involved with cleaning up hazardous substance spills and releases to develop and implement a written program which consists of:

- A site specific emergency response plan
- A response organization, including roles & responsibilities
- A comprehensive work plan and site maps
- An incident action plan procedure and process

A delayed or improper response to an incident involving hazardous substances, such as spills, leaks, fire and/or explosions, can have severe effects on shipyard workers and the environment (land,

water and air). To prepare for such incidents, shipyards develop and implement emergency response plans. The emergency response plan includes:

- A notification system for hazardous substance emergency incidents
- Procedures to follow if an emergency occurs
- Evacuation routes and gathering areas in the shipyard
- On-site emergency equipment and response personnel
- Pre-emergency planning and coordination with outside parties
- Personnel roles, lines of authority and communication
- Emergency recognition and prevention
- Safe distances and places of refuge
- Site security and control
- Decontamination procedures
- Emergency medical treatment and first aid
- Emergency alerting and response procedures
- A critique of the response and follow-up
- Personal Protective Equipment (PPE) and emergency equipment

Goals of Emergency Planning

The ultimate goals of the shipyard emergency response plan should be prioritized and stated in the plan. They should generally take the following order:

1. **Life and health** - The well being of responders, persons needing rescue and other employees should be the first consideration during an emergency rescue.
2. **Environment** - Actions taken need to consider potential environmental releases before property.
3. **Property** - Protection of shipyard property is important, although it is the last priority.

It is important to understand the general purpose of planning. The process of planning for hazardous incidents represents a first step toward an effective response. The four basic steps of shipyard planning and emergency plan development are:

Step 1. Identify all potential hazardous materials dangers on-site from handling and storage, to processing.

Step 2. Identify all available and required resources, within the company and outside, through mutual aid agreements or private contractors.

Step 3. Determine training and equipment needs necessary to develop in-house emergency response capabilities.

Step 4. Validate the plan by conducting emergency response exercises. Start with table top exercises, then partial-functional exercises and graduate to full scale exercises involving the public agencies.

Objectives of Emergency Planning

There are four main objectives to consider in shipyard emergency response planning. They are described as follows:

1. **Preparedness -** Once the plan is developed, it must be continually reviewed and updated, trained and exercised, which enhances and maintains preparedness.
2. **Response -** Planning defines actions needed for responding to emergencies. Implementation of the incident action plan is made easy with proper initial design.

3. **Mitigation -** Predetermined methods used to contain or control releases including standard operating procedures or shutdown processes will enhance response time and effectiveness.
4. **Recovery -** By identifying procedures up-front, the process of restoring a production area and/or bringing a process back on line, is much more efficient. Recovery may include decontamination of the affected area and proper disposal of wastes. An investigation of the incident to determine the root cause should be conducted prior repairing equipment or rebuilding a process area.

Who Should be Involved with the Development Shipyard Emergency Response Plans

Emergency response plans are very important documents that will take several weeks to develop. They will be modified as processes and facilities in the shipyard change. Emergency response plans encompass information from nearly all areas of the shipyard and can affect nearly all departments. Utilizing a variety of departments and personnel in the planning process will give employees a sense of ownership in the plan. When all personnel are involved in its development it becomes a "living document" that employees are more likely to understand and use. The team planning process, utilizing the principles of Total Quality Management (TQM), includes using the following resources in it's development:

- Support from upper management
- The us of the following departments for information and modification:
  - ◊ Security, Environmental, Health & Safety, On-Site Fire and Medical Departments
  - ◊ Operations - Managers and Supervisors (ship repair and new construction)
  - ◊ Maintenance - Supervisors, Lead Foreman
  - ◊ Facilities - Engineers and Assistants
  - ◊ Engineering - Chemical, Mechanical, or Environmental
  - ◊ Support from Public Agencies: Agencies that would provide emergency services during a hazardous materials incident including, Police, Fire, Local Hospitals, Ambulance Services, etc.
- Support from the Local Office of Emergency Services.
- Other agencies providing support in a major incident are:
  - ◊ American Red Cross
  - ◊ Public Works

Environmental Cleanup Response Contractors

Contractors are frequently required to offer services under a facilities emergency response plan. Clean-up contractors are an invaluable resource. They can provide mass clean-up capabilities for oil spills or can provide Self Contained Breathing Apparatus ("SCBA") support for toxic emergencies. If the response time is adequate enough, the shipyard can eliminate purchasing and storing large amounts of clean-up materials. The following points must be considered:

1. The use of a contractor is often overlooked but an important part of emergency contingency planning.
2. The contractor should have a local facility or have the ability to respond within four hours.
3. The clean-up company should be involved in at least one exercise annually.

Emergency Response Plan Key Steps for Emergency Planning

All hazards and risks associated with the hazardous materials that are used and stored at the specific shipyard location should be clearly identified. Realistic and specific threat summaries should

be developed. The following list of steps should be referenced when developing facility specific emergency response plans:

1) Identify all resources within and available to the company:

- Personnel - with specific training and skills that may be applied to emergency planning and response.
- Equipment - for personal protection, mitigation and cleanup. Equipment may be on-site or available to the company through mutual aid and/or contractual agreements.

2) Conduct a needs assessment and the feasibility of fulfilling those needs.

- Identify properly trained personnel and appropriate equipment that is required to respond.
- Available options to smaller shipyards include, contracting with a spill response contractor.

3) Determine the best use of resources.

- Assign roles and responsibilities to personnel best suited for the job.
- This is a team effort.
- Remember, some people do not work well under stressful conditions.
- Responders must be selected carefully.

4) Identify roles and responsibilities.

- Identify roles of the outside agencies and how company personnel interacts with them.
- Include local agencies most likely to respond to their emergencies in the planning process.
- Develop an organizational chart illustrating the relationship between shipyard responders, response contractors and agency personnel in an emergency.

5) Identify and integrate with the local emergency response plan.

- Local community and county governments typically have an emergency preparedness plan.
- Conduct a community hazardous materials exercise to validate the plan.
- Integrate shipyard specific concerns and abilities with those of the local responders.

6) Establish lines of authority and communication methods.

- It is important to identify a primary and secondary means of communication with the various levels management during an emergency.
- Illustrate the flow of communication with an organizational chart.
- Ensure that all responders know the communication methods.

7) Use one operational system for emergency response organization.

- Establish an incident command system that works with the system used by local and state emergency response personnel.
- A similar emergency management system is recommended for shipyard emergency response involving plant personnel and responses involving outside agencies.

8) Determine isolation zones and safety perimeters.

- A safe refuge area should be identified, up-front, in anticipation for emergency situations.
- Shipyard process areas and/or warehouses may be identified as initial isolation zones or meeting places during an emergency.

9) Identify evacuation routes.

- Clear, safe, routes and relocation areas should be identified and posted in a conspicuous place.
- Standard operating procedures and training about evacuation routes is required by OSHA.

10) Develop site security and control procedures.

- Security within facility boundaries is typically controlled by company personnel. Designated personnel should be trained to the Operational Level.
- Pre-plan with local police for controlling access to the facility.

11) Define the alarm systems, monitoring and method of activation.

- Separate and distinctive alarms should be used for a specific type of emergency. Alarms should include fire, chemical release, medical emergency and others as necessary.
- Monitoring systems should be used to detect the presence of specific chemicals when released into the atmosphere.

12) Emergency notification procedures and checklists.

- Details of when to notify, in what order and who shall notify must be included in the notification procedures.
- Checklists and fill-in-the-blanks forms are excellent tools for accomplishing these tasks.

13) Procedures for handling the emergency and checklists.

- Procedures should be strategic and tactical. The Incident Commander follows guidelines for developing an incident action plan to communicate and document strategies. Operations follows guidelines and standard operating procedures for tactical plans.
- Checklists and forms are excellent tools that should be included in emergency response plans.

14) Medical monitoring and emergency treatment procedures.

- Medical monitoring shall include baseline vitals, pre-entry and post-entry for all responders expected to suit up in level A or level B chemical protective clothing.
- Emergency rescue and first aid procedures should be included in the emergency response plan.

15) Personal protective equipment (PPE).

- A description of the various levels of personal protective clothing, breathing apparatus, monitoring devices should be included.
- Be chemical specific when describing the levels of protection needed and monitoring devices.

16) Decontamination and disposal procedures.

- Include decontamination methods and equipment needed for specific chemicals.
- Consult federal, state and local regulations for proper disposal methods.

17) Termination and recovery procedures.

- Define when an incident is considered stabilized and when clean-up operations can begin. Who conducts the clean-up phase of the incident? Who determines when it is safe for non-emergency response personnel to re-enter the workplace.
- Recovery phase of an incident should include a start-up after emergency shutdown standard operating procedures.

19) Reference your medical surveillance program

- Include qualified medical certification of personnel required to wear chemical protective clothing and respiratory protection.
- Include a method for recording chemical exposures and the person or the department that is responsible for maintaining records.

20) Training requirements.

- Identify frequency of training, periodic review of the emergency response plan and standard operating procedures.
- Describe elements of the training program: curriculum, hours, prerequisites, instructor qualifications and refresher training.

- Identify person responsible for maintaining records and ensuring periodic review of curriculum and plans.

Event-Specific Incident Action Plans - Strategic Objectives and Elements

Incident Action Plans are an excellent tool that Incident Commanders and Scene Managers use to identify specific incident problems and resources available to minimize potential adverse outcomes. The incident Action Plan is a tool developed by the shipyard in their emergency response plan. Some shipyard will combine the incident action plan with the site safety plan as discussed in the next section. The strategic elements and objectives of the Incident Response Plan are displayed in the following table.

Element	Description
Safety	The safety of all personnel on site must be the first consideration. When an alarm or another outward warning indicates a possible hazardous materials release, HazMat Responders must always consider the location of employees, in relationship to the source. Everyone should remain upwind, upgrade and upstream of any release.
Isolate and Deny Entry	An evacuation of the immediate area and control of entry points to protect other personnel in surrounding areas. Isolation perimeters are established at this time.
Notification	Early notification is not only important, but mandatory under various federal, state and local laws and regulations. The plan should include a checklist and log of all notifications.
Command	The incident action plan should include an organizational chart identifying the incident commander, command staff and sections that are to be activated. Personnel in these various positions should be identified by name. Any other company or agency involvement should also reflect in the organizational chart.
Identification and Hazard Assessment	Site plans, signs, labels, color codes and monitors should make identification of the released material at buildings and storage areas more efficient. The emergency response plan should address hazard assessment for all suspected substances. Always locate and review the assessment during the incident to help ensure proper precautions.
Action Plan	Identify the strategic objectives of this response. Example: rescue, reconnaissance, containment, control, or no action, until adequate resources arrive.
Protective Equipment	The Incident Response Plan should include a statement ensuring proper protective equipment shall be selected and means to enforce compliance with wearing it.
Containment and Control	Ensure there are appropriate resources available before taking action. Have equipment and procedures in place for containment and control.
Protective Actions	Proactive measures and actions that may need to be taken for protection of persons beyond the fence line of the facility. These include evacuation, or shelter-in-place.
Decontamination	A statement in the incident action plan ensuring appropriate decontamination of personnel and equipment shall occur prior to termination of emergency activities.
Disposal	A continuation of termination activities includes disposal. The incident commander must ensure that these activities are carried out in compliance with federal, state and local laws and regulations.
Documentation	Its not over until the paperwork is done. The last of the termination activities must include an incident debriefing. Gather and/or finish writing all documents, conduct post incident analysis and finally the critique.

Event-Specific Site Safety Plan

A written Site Safety Plan is recommended for all hazardous substance incidents. All phases of the incident are to be addressed in the plan and all personnel on site are to be made aware of the plan contents. Poor management and lack of planning have been identified as common problems associated with hazardous materials incidents. By conducting a thorough site safety evaluation, all aspects of personnel safety, including the management structure, will be covered in the event-specific plan.

Site Safety Planning: The purpose of the Site Safety Plan is to keep the personnel at the event safe, establish standard operating procedures, establish command structure and provide a briefing document for responders. This ensures that all are informed of the objectives, plans and contingencies. The Site Safety Plan must accomplish the following:

- Name key personnel and alternates responsible for site safety.
- Describe the risks associated with each operation conducted.
- Confirm that personnel are adequately trained to perform their job responsibilities and to handle the specific hazardous situations they may encounter.
- Describe the protective clothing and equipment to be worn by personnel during various site operations.
- Describe any site-specific medical surveillance requirements.
- Describe the program for periodic air monitoring, personnel monitoring and environmental sampling, if needed.
- Describe the actions to be taken to mitigate existing hazards to make the work environment less hazardous.
- Define site control measures and include a site map.
- Establish documentation procedures for personnel and equipment.
- Set forth the site's Standard Operating Procedures ("SOP").
- Set forth a Contingency Plan for safe and effective response to emergencies. SOPs are appropriate for those activities that can be standardized and where a checklist can be used.

All procedures for Incident Action Plans and Site Safety Plans should be prepared in advance based on the best available information about the potential incident, operational principles and technical guidance. They should be appropriate to the types of risk at that site. Procedures should be field tested by qualified health and safety professionals and revised as appropriate. They also need to be easy to understand and practice. Personnel who will perform these activities should be provided with copies of the SOPs. Regular training programs should include a review of these SOPs.

Developing a Written Incident Response Plan or Site Safety Plan

One of the best ways to develop a Site Safety Plan is to start with a standard form or template to help the Incident Commander and HazMat Technicians focus on the elements necessary to ensure worker safety. The following is an overview of the elements which should be addressed:

Background information - Includes a discussion of the history of the area and current activities taking place. A description of the surrounding employees, operations and normal conditions.

General Safety Statement - Safety of the response personnel is of the highest priority. All personnel are cautioned to work in a safe manner and to report any unsafe actions or conditions to their supervisor, or the Safety Officer, immediately. All personnel are to be briefed on the contents of the plan.

Training - All personnel are to be trained for the function or task assigned. The plan should explain the training required for the site, including training required by 29 CFR 1910.120 and any other types required by other occupational health standards or company policies.

Identification of key personnel - The following personnel should be identified by name: site manager, site safety & health officer, emergency response team, field team workers, site security,

safety & health advisor, outside contractors, any other personnel who will routinely enter or have involvement with the site.

Roles and responsibilities - Roles and responsibilities of key personnel should be clearly outlined on the site safety & health plan.

Safety, Health and Hazard Risk Assessment - The product involved in the incident shall be identified by chemical name and UN number. The primary/secondary hazards shall be listed. All personnel shall be briefed on the pertinent information obtained technical references regarding the material.

Site Organization or Command Structure - Federal law mandates that an Incident Command System be in place at all hazardous materials incidents. The system and personnel assignments are to be identified prior to site work activities. The command structure shall be identified on a separate page.

Incident Action Plans for Operations - Entry personnel shall have written objectives, understand such directives and follow those objectives in the performance of their duties. All personnel shall be briefed on the incident objectives documented on a separate form. Incident Objectives are to be incorporated into the Site Safety Plan.

Personal Protective Equipment Required in Controlled Zones - The proper personal protective clothing and equipment needed for each zone shall be documented. Example:

1	Exclusion (Hot) Zone:	Level:	Specifically:
2	Contamination Reduction (Warm) Zone:	Level:	Specifically:
3	Support (Cold) Zone:	Level:	Specifically:

Medical Monitoring Procedures and Exposure Documentation - All personnel using encapsulating chemical protective clothing shall have medical monitoring of pulse, blood pressure, respiration and body core temperature prior to and following, work activities. Those personnel whose recovery from the activities does not meet acceptable medical standards shall be barred from further work, until cleared by qualified medical personnel. Personnel who have had contact with the product shall have their exposure documented and treated.

Monitoring for Hazards and Sampling Procedures - The Exclusion Zone shall be monitored for primary/secondary hazards by using monitoring devices. Samples of the materials shall be obtained and analyzed by trained responders. Samples shall be retained in the event that they may be needed in the future. Containers with the product, or materials contaminated with the product, shall be clearly labeled and placed in proper secondary containment and segregated as appropriate.

Decontamination Procedures - To limit the spread of the contaminant, all personnel and equipment exiting the Exclusion Zone shall be decontaminated under the direction of the Decontamination Leader. Containment of the product within the Exclusion Zone shall be accomplished by limiting contact of the material, maintaining a clearly defined entry and exit and the use of proper decontamination procedures for personnel and equipment. All personnel shall be briefed on the decontamination procedures as established by the Decontamination Leader.

Recognition of hazards on the site -This section should include potential chemical hazards, heat stress hazards, hazards from utilities, fire and explosion hazards, heavy equipment hazards, traffic hazards, excavation hazards, noise hazards and confined space hazards.

Site Control Measures (including Control Zone Locations) - Access to all areas of the incident shall be limited to necessary and key personnel only and enforced by the Site Access Control Leader. All personnel shall remain within the Support Zone unless otherwise directed by the Entry Leader or Decontamination Leader. Persons entering the Exclusion Zone shall be wearing proper protective equipment. All personnel shall be briefed on the locations of control lines and control zones as established by the Site Access Control Leader. The control measures are to be incorporated into the Site Safety Plan. A map of the site/area is to be included in the plan as well.

Response to Unplanned Events and Emergencies - In the event of an emergency, or other unforeseen circumstance, personnel shall be notified by radio or repeated long blasts of a whistle or air horn. The following are examples of emergency response (contingency) plans:

> Entry Emergenc y Entry personnel shall stop work, move to safe refuge and await direction from the Entry Leader. Decontamination personnel shall staff the decontamination area and await direction from the Decontamination Leader. All non-essential personnel, including the media, shall leave the Support Zone pending a situation assessment.
>
> Fire Emergenc y In the event of a fire emergency involving the product, (extinguishing agent) shall be used and a (distance) perimeter established. A Fire Group has been established in the support area to watch for fires and provide suppression and rescue resources as needed.
>
> Medical Emergenc y In the event of a medical emergency involving the product, the person shall be completely decontaminated prior to transport from the scene. The designated receiving facility (name of hospital) has been notified and transport will be provided by (standby ambulance). Other medical emergencies or response personnel requiring first aid are directed to the Medical Unit Leader. The Medical Plan is to be incorporated into the Site Safety Plan.

Procedures for Confined Spaces, Back-Up and Escape - Situations where personnel are operating in Level A suits, confined spaces, atmospheres in excess of the Immanently Dangerous to Life Health (“IDLH”) level, or with an unknown contaminant, shall have rescue personnel immediately available prior to entry, as well as a method for extrication and removal. Personnel shall conduct all physical activities utilizing the buddy system. Working alone in protective clothing is not permitted. The Entry Team shall exit the Exclusion Zone in the event of equipment malfunction in order to replace or repair such equipment.

Medical Surveillance and Monitoring - Requirements for the site should be discussed thoroughly. This section should also discuss who should be contacted for both non-emergency and emergency occupational health care.

Communications Plan - A communications plan shall be established to identify radio frequencies and other forms of communication in use, as well as who can use them. ICS Form 205 can be used for the communications plan and attached to the Site Safety Plan.

The purpose of a Incident Response Plan is to ensure the safety of personnel through the analysis of safety elements, establish procedures and establish a command structure. The Incident Response Plan is developed and written by the Incident Commander with assistance from HazMat Technicians. All personnel must be briefed on the plan prior to the entry in the exclusion zone. The Incident Response Plan provides a briefing document for responders to ensure that all are informed of the objectives, plans and contingencies.

Sample Site Safety Plan/Incident Response Plan

Incident Name:	Incident #	Date:	Operational Period:

Site Information:
Incident Location:
Safe Access Route to the Site:
Command Post Location:
Control Zones are indicated on the Site Map and identified by:
Exclusion Lines:
Contamination Control Lines:
Support Lines:
Weather Conditions:
Wind Direction: _____________ Speed: ___________ Temp/Time: ____________
Forecast:
Note: Site Map shall be completed and attached.

Organization	
Incident Commander:	
HM Group Supervisor:	Safety Officer:
HM Tech. Reference:	Asst. Safety / HazMat:
Safe Refuge Area Mgr.:	Site Access Control:
Entry Leader:	Decon Leader:

Entry:	Back-Up:	Decon:
Entry:	Back-Up:	Decon:
Entry:	Back-Up:	Decon:
Entry:	Back-Up:	Decon:

Hazard Evaluation Summary
Chemical Name(s):
Hazards:
Note: Hazardous Material Data Sheet(s) shall be completed and attached.

Safety
Personnel shall not enter the Exclusion Zone without proper protective equipment and authorization from the Entry Leader.
General Hazards and Safety Precautions:
Lighting shall be provided, in accordance with OSHA regulations, to maintain a safe working environment.

Site Air Monitoring	
LEL instrument(s):	_____ continuous, or:
O_2 instrument(s):	_____ continuous, or:
Toxicity /PPM instrument(s):	_____ continuous, or:
Radiological instrument(s): alpha, beta, or gamma	_____ continuous, or:
Ground Water Monitoring: Yes / No	
Comments:	
Proper protective precautions shall be employed for personnel working where sound levels exceed limits.	
Protective Clothing	
Entry:	
Backup:	
Decon:	
Recommended guidelines shall be followed for personnel in chemical protective clothing.	
Decontamination	
Decon Corridor Location:	
Standard Department Decontamination Layout utilized: Yes No	
The modified layout and procedure will consist of:	
Decon solution for Personnel:	
Decon solution for Equipment:	
Decon Procedures shall be followed for personnel and equipment exiting the Exclusion Zone.	
Communication	
Radio Frequencies assigned: Command: Tactical (Entry Team):	
Additional Communications utilized:	
Visual contact with the Entry Team shall be maintained at ALL times, or as follows:	
Emergency Hand Signals shall be reviewed with the Entry and Decon teams.	
ONLY the Entry and Backup Team, Decon Leader and Asst. Safety Officer/HazMat shall utilize the assigned Tactical Channel.	

Health	
Emergency First Aid and transportation will be provided and the medical facility will be notified of the situation resulting in the injury.	
Medical Unit Location:	
Entry and Decon Personnel shall have Pre-Entry and Post-Entry Vitals completed by qualified personnel. This information shall be recorded on a Medical Monitoring Form. The Medical Monitoring Form shall be attached to the Site Safety Plan.	
Poison Control Center Notified: [ ] Yes [ ]No	
Toxicology, signs and symptoms and exposure treatment information is contained within the attached Hazardous Materials Data Sheet. This information shall be: • provided prior to work activities for known involved materials • provided following testing of unknown materials • reviewed at the Post Incident Debriefing • available upon request	
Hygiene and rest room facilities are located at:	
Emergency Procedures	
Citizens within the Exclusion Zone shall be directed to the Safe Refuge Area to await assessment and instructions for appropriate protective actions. The Safe Refuge Area is located at:	
Equipment Failure: In the event of equipment failure that effects the safety of the personnel working in the Exclusion Zone, Entry Personnel shall immediately leave the Exclusion Zone. Re-entry is no t permitted until the equipment is repaired or replace . d	
Rescue: In the event a rescue of the Entry Personnel is required, the Backup Team shall be notified by and receive final instructions.	
Fire: In the event of a fire or explosion, the Fire Suppression Group will be:	
Escape/Evacuation Alarm:	
Entry Team Escape Route:	
All support personnel shall evacuate to:	
The situation will then be assessed for appropriate corrective actions.	
Training	
All personnel:	
1. Have the required or equivalent training to perform the task or function assigned. Yes [ ] No [ ] 2. Have the required or equivalent training to wear and/or operate assigned protective equipment. Yes [ ] No [ ]	
Plan Review	
All Entry, Backup and Decon personnel have been briefed on the plan prior to entry. The Plan shall be available for review by all personnel. Changes shall NOT be made to this plan without the approval of the Asst. Safety Officer/HazMat.	
Asst. Safety Officer/ HazMat, SIGNATURE:	Date/Time
HazMat Group Supervisor, SIGNATURE:	Date/Time
Incident Commander, SIGNATURE:	Date/Time
Documents Required to Complete This Plan	
Attach required amendment(s) to document changes in this plan: Site Map [ ] Incident Objectives [ ] MSDSs [ ] Medical Monitoring form with Pre-Entry and Post-Entry vitals for Entry and Decon Personnel [ ]	

Sample Site Safety Plan Amendment Sheet

Incident Name:	Incident #	Date:	Operational Period:

Check Amended Sections		
Site Information [ ]	Organization [ ]	Hazard Evaluation [ ]
Mitigation Actions [ ]	Safety [ ]	Monitoring [ ]
Protective Clothing [ ]	Decontamination [ ]	Communications [ ]
Training [ ]	Health [ ]	Emergency Procedures [ ]
Item(s) Changed		
Plan Review		

Changes shall NOT be made to this plan without the approval of the Asst. Safety Officer/HazMat. Plan amendments shall be documented, attached, reviewed b ally personnel and made available upon request.

Prepared by (Asst. Safety Officer/HazMat) Signature:	Date	Time
Reviewed by (HazMat Group Supervisor) Signature:	Date	Time
Approved by (Incident Commander)	Date	Time

Signature:		

Sample Site Safety Plan Instructions

General Instructions

- Items requiring additional documentation are indicated with the following symbol: Additional documentation required includes a Hazardous Materials Data Sheet, a site map, a Medical Monitoring Form and a Site Safety Plan Amendment (as needed).
- Review contents of the Plan at the Safety Briefing.
- Submit copies of the completed Plan to the Command Post for dissemination to resources.

Section Instructions: The following instructions are provided for further clarification.

Section	Instructions
Site Information	Provide information about the site and prevailing weather conditions. Indicate how Control Zones are identified (i.e., barrier tape, traffic cones, chain link fence surrounding property). Attach a copy of the ICS Form 201 with a site map.
Organization	Enter the names of personnel assigned to each position.
Hazard Evaluation	Complete and attach a Hazardous Materials Data Sheet. (This is required for risk assessment and hazard communication to the workers.) Enter the information from the Hazardous Materials Data Sheet in this section.
Mitigation Actions	Enter the actions taken to mitigate the existing hazards. (Incident Objectives are identified on ICS Form 202.)
Safety	Identify general hazards and the appropriate safety precautions.
Monitoring	Identify the specific instruments to be used. Identify the monitoring frequency if monitoring will not be continuous.
Protective Clothing	Enter the level of suit, the suit type and the glove type recommended from the Hazardous Materials Data Sheet.
Decontamination	Enter the information from the Site Map and the Hazardous Materials Data Sheet. Indicate whether or not a standard decontamination layout is used, or identify the alternate decontamination setup and procedure.
Communications	Indicate the radio frequencies assigned.
Health	Pre-Entry and Post-Entry Vitals shall be taken on all Entry and Decon Personnel by a qualified individual. This information is to be entered on a Medical Monitoring Form which shall be attached to the Site Safety Plan. Health Hazards and appropriate treatment information shall be entered on the attached Hazardous Materials Data Sheet.
Emergency Procedures	Complete the remaining portions of the Emergency Procedures section.
Training	Deviation from the training requirements should be documented on the ICS Form 214 by the Unit Leader in charge and the Assistant Safety Officer/HazMat. The Entry Team shall be briefed on facility specific information by a facility representative. Place a check in the box [ ] to indicate that the personnel on site have the appropriate training. Use the line provided for special requirements or modifications if necessary.
Plan Review	All Entry, Backup and Decon personnel must briefed on the plan prior to entry. The plan shall be available for review by all personnel. The Assistant Safety Officer shall review and approve the plan.
	Site Safety Plan Amendment Sheet
Check Amended Sections	Indicate which sections have been amended.
Items	Provide details on amendments made to the original plan.
Plan Review	The Assistant Safety Officer shall prepare the plan. The HazMat Group Supervisor shall review the plan. The Incident Commander shall approve the plan. The plan shall be available for review by all personnel.

Hazardous Substance Data Sheet

Material Information

- Shipping name _________________ Emergency phone # ______________________
- Chemical name _________________ Manufacturers phone # ____________________
- DOT Hazard Class _____ ________ UN / NA ID# _____________________________

Physical Description

- Physical For m Solid ____ _ Liquid _____ _Gas _______
- Color _______
- Odor ________
- Other ________
- Hazardous component s Chemical Nam e CAS # % by wt.

____
____
____
____

Properties

- Specific Gravity ________ Density __ _____________
- Vapor Density _________ Boiling Point ____________
- Melting Point __________ Solubility in Wate r (Yes or No)

Toxic Human Hazards

- Inhalation hazar d(Yes or No)
- Symptoms of inhalation exposure ____
- TLV/ TWA __________________ (ppm (mg/m3) LC-50 ___________ (ppm/hr)
- Ingestion hazard (Yes or No) LD-50 ___________ mg/kg
- Skin and eye contact hazard (Yes or No)
- Carcinogen (Yes or No) Teratogen (Yes or No) Mutagen (Yes or No)

Fire and Explosion Hazard

- Fire hazard (Yes or No) Toxic by products (Yes or No)
- Flash point ________________ Autoignition temp. __________
- UEL ___________ (%) LEL ___________ (%)

Reactivity, Corrosivity and Radioactivity

- Reactive (Yes or No) with water (Yes or No) with air (Yes or No)
- Corrosive (Yes or No) Acidic (pH) ______ _ Basic (pH) __________
- Radioactive (Yes or No) Background, Alpha particle, Beta particles, Gamma radiation

Personal Protective Equipment Needed

- Respirator (Yes or No) What type? ________________
- Gloves (Yes or No) What type? ________________
- Glasses (Yes or No) What type? ________________
- Recommended Level _____________

Incident Hazard Analysis Data Sheet

Quantity and Toxicity of Materials
What are the material health hazards? ____
What chemical quantities are involved? ____
Is there a fire or explosion potential? ____
What personal protective equipment (PPE) is needed? ________________________________

Potential Exposure to People, Property and the Environment
Are there any victims? ____
Any other potential human exposure, who is at risk? ________________________________
Is there adequate ventilation? (Yes /No) _______________________________________
Will the area become a **confined space hazard** due to
limited access ____ ____________________
insufficient ventilation ____
excessive toxicity ____
explosive or combustible fumes and vapors? _____________________________________
Event timing concerns ____
Is employee evacuation necessary? ____
Releases to environment (Yes / no) ____
Any Environmental Threats ____

Size, Type and Condition of Container
Is the container rusted or corroded? ____
Has the container been punctured or torn? _____________________________________
Is the container leaking? ____
Is the container bulging or dented? ____
Is the container potentially exposed to flame or heat? ___________________________

Levels of Resources Needed and Available
Is monitoring or sampling required ? ____
Is there a need for further resources? ____
Is notification required ? ____
What resources (human and equipment) are required and are readily available? __________
____
What can be done immediately? ____
Is diking necessary? ____
What containment equipment is readily available? ________________________________

Weather Conditions and the Site Terrain
What are the weather conditions? ____
Is it raining or is it a hot, dry day? ____
What is the topography. Is it flat, are there hills? _______________________________
Will the topography affect the approach considerations or evacuation considerations? ________
What is the terrain like? ____

Hazardous Incident Containment and Control Options

Action Options	Ideas and Actions
No Hazardous Intervention	Operational Level Responders who have a positive safety attitude will understand that this is frequently the best option. Do you know the chemical hazards involved? Is the situation extremely dangerous? Do you have the proper Personal Protective Equipment? Is it best to simply isolate the area and deny entry or prevent access?
Hazard Containment	• Is diking or damming an option to control or confine a liquid? • Should you use material to cover floor drains and man holes? • Should you retain or hold back, hold secure or intact (in natural low areas)? • Should you divert and turn the spill aside to change the spills course?
Hazard Control and Clean-Up	• Is uprighting the container a safe option? • Can a punctured drum be rolled over so that the hole is upward? • Will shutting off valves control the source? • Will dispersing and spreading the hazard be helpful? • Can the leak be plugged safely with hazardous response equipment • Can the chemical strength of the substance be diluted and diminished? • Should the materials be absorbed to clean-up the spill?
Hazard Confinement and Evacuation	Should the area be evacuated? To what extent? What are the evacuation options? Should the spill area be confined? Should air quality confinement or ventilation be initiated? Where should control zones be set up? 1. Exclusion Zone (Hot Zone or Inner Perimeter) 2. Contamination Reduction Zone (Warm Zone or Secondary Perimeter) 3. Support Zone (Cold Zone or Outer Perimeter)

Objectives and Methods For Control of the Hazardous Incident:

Sample Hazardous Incident Response Team
Event-Specific Safety Plan

Incident Name: _________________
Incident #: _____________________
Date: __________________________

Incident Commander or Scene Manager: ____
Safety Officer: ____
Entry Team leader: ____
Team Members:
1: ________________________________ **Training Level** ______________
2: ________________________________ **Training Level** ______________
3: ________________________________ **Training Level** ______________
4: ________________________________ **Training Level** ______________

Chemicals Involved (Names and CAS#) ____
____
____
____
Associated Hazards: Fire: ___ **Health:** ___ **Reactivity:** _____ **Others:**
____

Level of Protection Required for Entry: ____
____

Decon Team Leader:____
1: ________________________________ **Training Level** ______________
2: ________________________________ **Training Level** ______________

Level of Protection Required for Decon:
____

Problems Involved with Incident: ____
____
____
____

Objectives of Response: ____
____
____
____
____

Procedures of Response: ____
____
____
____

Session 5. Hazardous Incident Site Control Perimeters and Zones

Procedures and practices for hazardous incident site control, perimeter establishment and control zone implementation, can greatly enhance the safety of a hazardous incident. Proper procedures and a control program can serve to minimize potential contamination of workers, protect the public, protect the environment and contribute to overall safety, by controlling the movement of workers and equipment.

Incident Site Control

Site control is based on identifying various zones for control and reducing the accidental spread of contaminants by workers or equipment. The possibility of exposure to hazardous substances or the transfer of contaminants can be reduced or eliminated in a number of ways:

- Setting up security and physical barriers
- Maintaining the number of personnel and equipment on-site that is consistent with effective operations
- Establishing work zones within the site
- Establishing control points to regulate access to work zones
- Conducting operations in a manner to reduce the exposure of personnel and equipment
- Eliminating or minimizing the potential for airborne dispersion
- Implementing appropriate decontamination procedures

Site control is a critical element in hazardous materials emergency scene management. Establishing control zones and strictly enforcing access to those control zones, is absolutely necessary to ensure the safety of all personnel on scene. Initial site control is usually established by first responders prior to the arrival of additional help. Site control is the necessary mechanism to prevent the spread of contamination to humans or the environment. There are three principal objectives for site control:

- Isolating the incident
- Maximizing order and minimizing chaos and confusion
- Limiting or preventing the spread of contaminants

The degree of site control needed depends on many factors, including size of the site, the makeup of the surrounding area and the degree and types of contaminants. The site control program should be established before the beginning work and should be constantly modified to suit new information, new site assessments, or changing conditions.

Why is a site control program needed?
To control access to the hazardous incident site and to other contaminated work areas. Also, to prevent the spread of contamination to employees, the public, or the environment.

Who might become contaminated during a hazardous incident?

- Workers on site in "hot" work areas
- Workers in adjacent "clean" work areas
- Residents in surrounding communities
- Workers families or other immediate contacts (i.e., laundry service)
- Other persons who may enter the site

6 Elements of Site Control

The shipyard hazardous incident control program should include the following six elements:

1. Site Security to Prevent Unauthorized Entry and Procedure Adherence:
Site security can be accomplished with fences, posted warnings and signs and a number of other physical items. More importantly, security personnel should be positioned at access control points and a check-in system for a response personnel should be established.

2. Establishment of Site Work Zones:
A. Exclusion Zone - "hot," contaminated work area
B. Contamination Reduction Zone (CRZ) - “warm” decontamination area
C. Support Zone - "clean", uncontaminated area. Contains support base and command post

3. Site Communications:
Site communication is very important for control and safety. The following lists some important types of communication that must be considered in the incident site procedures:

- Audible alarms for emergency warning
- Hand signals between workers in areas where hearing may be difficult
- 2-way radios for communication under 1 mile.
- Permanent phone lines or land lines
- Communication systems may fail (ensure back-up communication)

4. The Buddy System Should be Used During Emergency Response:
The buddy system is an excellent safety procedure because it requires direct visual communication at all times. A buddy will be able to assist his/her partner when there are signs of chemical or heat exposure. The buddy can also check the integrity of PPE, notify the site safety officer or other designated responsible persons of any emergency involving his/her buddy and assist in rescue, if necessary.

5. Standard Operating Procedures and Safe Work Practices:
Each shipyard must identify all standard and safe operating practices to be performed during an hazardous substance incident. Some of the practices may include:

- Use of appropriate equipment (i.e., non-sparking tools, spark arresters on engines, etc.)
- Use of signaling/spotter when backing up heavy equipment
- Use of a "line-of-sight' worker or standby to observe all Level B, Exclusion Zone operations
- Keeping non-essential personnel in the Support Zone and at a safe distance from the work area

6. Site Maps:
A site map must be produced once there is sufficient information gathered about the incident. The map should detail all features that affect placement of zones, access control points and security fences. It is a key tool in establishing a hazardous clean-up site control program because it must convey characteristics of the shipyard, such as topography, prevailing wind direction, drainage and other prominent features (i.e. buildings, trees, buildings, streams, ditches, railroad tracks, etc.). The map must be highly specific and large enough to contain the layout of the various work zones and outlying areas. The maps will be used as a guide for planning, identifying areas of the site that require different levels of PPE and identifying evacuation routes.

Establishing the Control Lines and The Safety Perimeter

Emergency response personnel must gather information on the hazards involved. Then they must use available information sources to determine safe distances for establishing control lines and zones. The DOT Emergency Response Guidebook is a good source of information for establishing initial control lines. Other reference materials should be checked to confirm or adjust the control line placement as necessary.

Isolation and Incident Perimeters: Isolation of the incident usually begins with the first responder. That person declares the limits for entry and non-entry to the site. As the incident becomes more controlled with resources and trained personnel, this limit may be subdivided into additional zones. However, the initial limit is described as the incident perimeter and will describe the limit for untrained or non-contributors. Isolation is designed to limit exposures and reduce further contamination, as well as allowing those involved with the incident operation freedom from distractions. Only those people directly involved in the response should be allowed within the perimeter. Even response personnel who may be involved with staging, or as backup, should be kept at a safe distance (i.e. outside the perimeter).

Order and Control: Order and control are absolutely necessary for a successful mitigation of a hazardous materials/waste incident. There must be a single point of control (Incident Commander) and an air monitoring mechanism. The use of an incident procedure provides a mechanism to add order and control. The Incident Commander is responsible for the coordination and lines of communication for all personnel and agencies on site.

It is also important to assure that responders are working within their level of training resources. For example, entry into the Exclusion Zone should not occur until, at a minimum, decontamination procedures are in place and active. Requirements for entry team members must be set before assignment to an entry team can be made. There are other examples and these need to be addressed with plans to limit confusion or chaos, but failure is almost guaranteed without a procedure that defines order and logical sequence.

Contamination Control: Preventing the spread of contamination is a major focus of any hazardous incident. The uncontrolled movement of personnel and equipment through the incident areas creates a high risk of transferring the contaminate into areas where proper personnel protection may not be in use. Site control measures must prevent contact between the contaminated and uncontaminated areas, personnel and equipment.

Control Outside the Perimeter: The best way to protect people and property from a threatened or actual release of hazardous material is to separate them from the released material. This can take the form of using barrier tape to designate the spill area, to isolating a building, or even evacuating an entire shipyard. Shipyards must perform planning based on worst case scenarios and realistic scenarios. These scenarios will outline potential work zones, safe zones and control points. Having planned scenarios will help prevent responders and employees from becoming victims of the incident.

Control Inside the Perimeter: The perimeter and the area inside the perimeter are under the absolute control of the Incident Commander. It is important that all activities be coordinated and controlled through the Incident Commander to prevent response personnel, or other involved parties, from acting independently and thus endangering the health and safety of themselves and others. In an emergency, persons not involved must be kept outside the site perimeter. These include

onlookers, media not part of the press group, plant workers not involved in the response and those serving as backup to the response (staged resources).

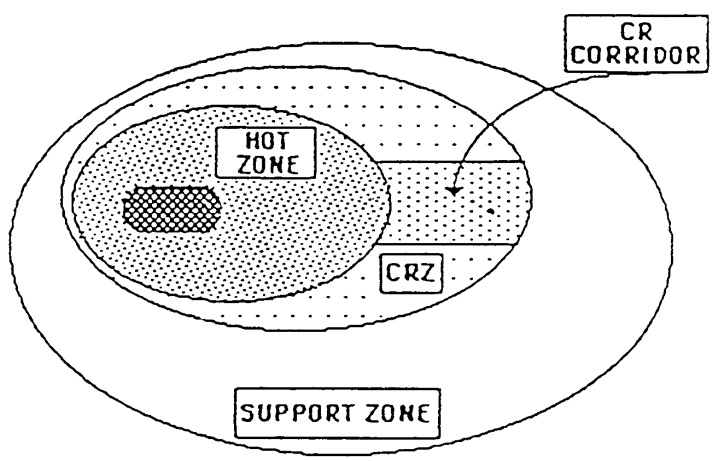
Utilization of pre-established planning for managing the incident should promote adherence to standard operating practices and an organized response. Practices must be followed especially when emergencies involving coworkers are involved. Rescuers acting on impulse rather than according to the prescribed procedure, may become additional casualties of an incident in their attempt to assist their friends.

Perimeter distance from the site or incident is the most valuable weapon in minimizing transfer of hazardous contamination. Due to the unpredictable nature of hazardous material incidents the following factors must be taken into account:

- Distance allows the most protection for the response team and freedom from interference
- It is always easier to reduce the perimeter than expand it
- Distance can also complicate the incident by draining staff
- Large perimeter areas require more staff to maintain
- Lapses in perimeter control that allow entry from other than designated entry points, will result in the break-down in site control
- A smaller perimeter area is preferable to one that has the potential for loss of control
- Staging for additional major resources (i.e., trucks, damming materials, barricades, food) will be outside the perimeter area
- Only the required resources should be inside the perimeter (fewer resources to move in the event of a major change)
- It is important to plan the staging area with good access to the entry area
- Provisions for roads, traffic flow, communications (land lines) and physical space

Site Control Zone Approach

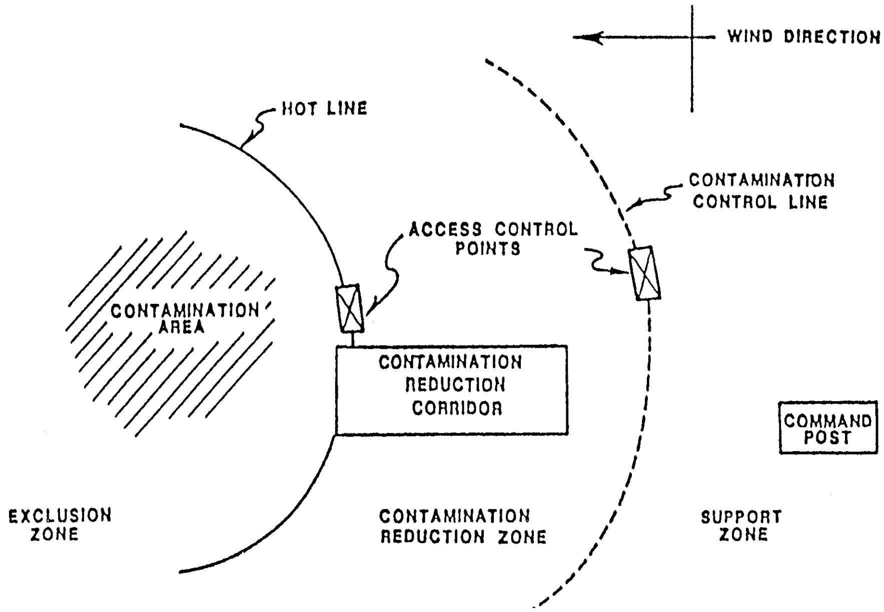
One method of preventing or reducing the migration of contaminants is to set-up zones at the incident site and prescribe operations to be performed in each zone. Movement of personnel and equipment between zones should be limited by access control points. The establishment of such zones will help ensure that shipyard personnel are protected against the hazards present in each incident area. With the control zone approach, contamination is confined to specific regions and personnel are required to wear prescribed PPE.



Three contiguous zones are frequently used during hazardous incident response. Each individual hazardous incident, depending on size and degree of contamination, may require many specific zones in a variety of arrangements. The following zones are recommended as a minimum:

Zone 1: Exclusion Zone, “Hot Zone” the contaminated area
Zone 2: Contamination Reduction Zone (CRZ), the area where decontamination takes place
Zone 3: Support Zone, an uncontaminated or "clean" area

Zone 1: Exclusion Zone



The Exclusion Zone is the area immediately around the spill where contamination is in it highest concentration. It is the innermost of the three zones and forms the Exclusion Line or Hot Line. PPE is always required for all personnel operating within the zone. All personnel will require decontamination upon exiting the Exclusion Zone. Entry and exit checkpoint or access control points must be established at the periphery to regulate the flow of personnel and equipment into and out of the zone. Access control points are also used to verify that the procedures established to enter and exit are followed.

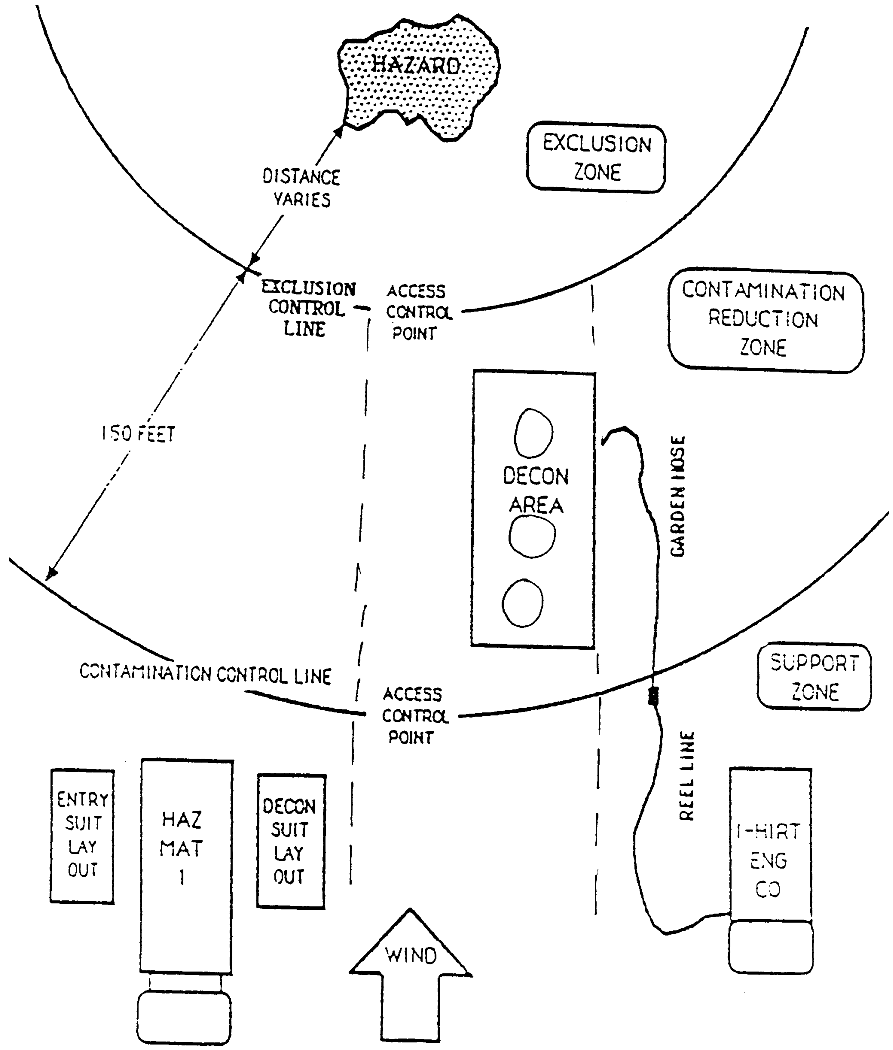
The outer boundary of the Exclusion Zone is the Hotline. It is initially established by visually surveying the immediate environmental factors and hazards of the incident and determining the locations of any hazardous substances. Guidance in determining the boundaries is also provided by data from the initial site survey indicating the presence of organic or inorganic vapors/gases, particulates in air, combustible gases, radiation, and/or other hazards discovered.

There are several methods that can be used in determining the location of these zones. A worse case scenario can be described for some locations. This involves some assumptions and must not be characterized as fitting all situations. The plan can describe roads, streets, topography, wind, sensitive receptors, etc. The only line that is measured is the Hot Line. The exact line is established when personnel with the level of resources (meters, PPE, etc.) and training (minimum technician level), are available and directed by the Incident Commander. The Hot Line should be placed at a distance from 25 to 150 feet from the release location. Additional factors that should be considered to determine zone separation distance include:

- The distances needed to prevent fire or an explosion from affecting personnel outside the zone.
- The physical area necessary to conduct site operations
- The potential for contaminants to be blown from the area

Once the Hotline has been determined, it should be physically secured and clearly marked by lines, placards, hazard tape or signs, or enclosed by physical barriers such as chains, fences, or ropes. During subsequent site operations, the boundary may be modified and adjusted as more information becomes available.

Note: Different levels of protection in the Exclusion Zone might also be designated by job assignment. For example, collecting samples from open containers might require Level B protection, but, while performing ambient air monitoring, Level C protection might be sufficient. Different levels of protection for various assignments within the Exclusion Zone generally makes for a more flexible, effective and less costly operation, while still maintaining a high degree of safety.



Zone 2: Contamination Reduction Zone (CRZ)

The Contamination Reduction Zone (CRZ) is the transition area between the contaminated area and the clean zone. The CRZ serves as a buffer to reduce the probability that the clean zone will become contaminated. It provides additional assurance that the physical transfer of contaminating substances on people, equipment, or in the air, is limited. The CRZ emphasizes a combination of decontamination, sufficient distance between Exclusion and Support Zones, air dilution, zone restrictions, required PPE and set work functions.

The Contamination Reduction Corridor is located in the CRZ. This is also frequently referred to as the decontamination (decon) area. No contamination should pass the Contamination Control Line.

Initially, the CRZ is considered to be an uncontaminated area. At the boundary between the Exclusion and CRZ, Contamination Reduction Corridors (with decontamination stations), are established for personnel and for equipment. Exit from the Exclusion Zone is through a Contamination Reduction Corridor. As operations proceed, the area around the decontamination station may become contaminated, but to a much lesser degree than the Exclusion Zone. On a relative basis, the amount of contaminants should decrease from the Hotline to the Support Zone.

Personnel entering the CRZ must wear the prescribed personnel protective equipment required, for working in this area. Similarly, entering the Support Zone requires removal and decontamination of any protective equipment worn in the CRZ.

A monitoring and sampling program should be implemented to verify that site control is succeeding in minimizing contamination transfer goals. The outlying zones should be periodically monitored for air contaminants using direct-reading instruments and collecting air samples for particulate, gas, or vapor analysis. At extremely hazardous sites, analysis of soil samples could help indicate the presence of contaminants being carried from the Exclusion Zone via personnel, equipment, or natural forces.

Zone 3: Support Zone

The Support Zone is a non-contaminated area outside of the Contamination Control Line. The Command Post, direct support facilities and those personnel with a direct or specific contribution to the incident are usually located in this area. Support zone personnel are responsible for alerting the proper agency in the event of an emergency. All emergency telephone numbers, evacuation procedures and maps and vehicle keys should be kept in the Support Zone. Support equipment (equipment trailers, fire trucks, etc.) are located in this zone and traffic is restricted to authorized response personnel. Since normal work clothes are appropriate within the support zone, potentially contaminated personnel clothing, equipment and samples are not permitted. Potential contamination must be left in the CRZ until they are properly decontaminated.

The immediate staging area for the entry teams to the incident should be located within the Support Zone. Supplies, equipment, tools, etc. are laid out and prepared for the entry team in the support zone. Within the Support Zone, opposite the entry side (adjacent to the decontamination station) is the medical support area. Medical staff are present for the entry team or any unexpected medical situation arising from the entry process, decontamination process, or monitoring process.

The location of the command post and other support facilities in the Support Zone depends on a number of factors such as:

Accessibility and topography:	Open space available for area where locations of highways, buildings, equipment, or other limitations
Wind direction:	Preferably the support facilities should be located upwind of the Exclusion Zone. However, shifts in wind direction and other conditions may be such that an ideal location based on wind direction alone does not exist.
Resources:	Adequate access to roads, power lines, water and shelter.
Visibility:	Should have a clear line of sight to all activities in the Exclusion Zone.
Distance:	A balance of distance from the Exclusion Zone is necessary

Other Considerations

Site Control Modifications: The use of a three-zone system with access control points and full decontamination procedures provides a reasonable assurance against the transfer of contamination. This site control system should be based on a "worse case" situation. Less stringent site control and decontamination procedures may be utilized if more definitive information is available on the types of substances involved and hazards they present. This information can be obtained through air monitoring, instrument survey and sampling and technical data concerning the characteristics and behavior of material present.

Area Dimensions: The distance between the hotline, contamination control line and command post and the size and shape of each zone, have to be based on conditions specific to each hazardous incident. Considerable judgment is needed to assure that the distances between zone boundaries are large enough to allow room for the necessary operations, provide adequate distances to prevent the spread of contaminants and eliminate the possibility of injury due to explosion or fire. The following criteria should be considered in establishing area dimensions and boundary distances:

- Physical and topographical features of the site
- Weather conditions
- Field/laboratory measurements of air contaminants and environmental samples

- Air dispersion calculations
- Potential for explosion and flying debris
- Physical, chemical, toxicological and other characteristics of the substances present
- Cleanup activities required
- Potential for fire
- Area needed to conduct operations
- Decontamination procedures
- Dimensions of contaminated area
- Potential for exposure

Monitoring and Sampling: To verify that site control procedures are preventing the spread of contamination, a monitoring and sampling program should be established. The Support Zone should be periodically monitored for air contaminants using direct-reading instruments and/or collecting air samples for particulate, gas, or vapor analysis. Analysis of soil samples collected in the area with the most traffic would indicate contaminants being carried from the Exclusion Zone by personnel, equipment, or wind. Occasional swipe tests may be taken in trailers and other areas used by personnel to check for contamination.

Session 6: Introduction to Confined Spaces

Confined space emergencies involving hazardous materials can pose unique challenges and risks to Shipyard HazMat Technicians. Therefore, confined space scenarios need to be fully evaluated in order to cover all potential aspects of HazMat emergencies in shipyard settings. Prior to looking at the emergency aspect of confined spaces, a general overview of the state and federal regulations that govern work activities within confined spaces during non-emergency and routine work is needed.

There are approximately 50,000 emergency responses to occupational confined space hazards each year in the USA. The National Institute for Occupational Safety and Health ("NIOSH") estimates that confined space work results in over 2,500 accidents per year in the marine industry alone. Many of these accidents are fatalities and over half of the victims are would-be rescuers. Addressing these alarming statistics, the federal Occupational Safety and Health Act ("OSHA") enacted 29 CFR 1910.146, the "Rules and Regulations for Confined Space Entry" on April 15, 1993. Similarly, OSHA 1910.120 Hazardous Waste Operations and Emergency Response regulations require training for individuals involved in clean-up or emergency responses. Both enactments define confined space entry procedures, which may need to occur during a hazardous emergency response or other incidents.

Confined Space Entry

Confined spaces in the shipyard can range from shipboard compartments to large pipes and tanks. Many of the confined spaces are unique and need special attention. The general description of a confined space, according to state and federal regulations, is:

1. Large enough and so configured that an employee can bodily enter and perform assigned work
2. Has limited or restricted means of entry or exit (e.g., pits, tanks, vessels, etc.)
3. Is not designed for continuous employee occupation

All confined spaces must be evaluated, based on potential hazards and classified into "permit-required" or "non-permit required" spaces. A permit-required confined space must have one or more of the following:

1. Contain or have the potential to contain a hazardous atmosphere
2. Contain a material that has the potential for engulfing the entrant
3. Contain any other recognized serious safety or health hazard

Non-permit required confined spaces are spaces that contain no hazardous atmospheric conditions and are not capable of causing death or serious harm.

NIOSH Definition of a Confined Space

NIOSH defines a confined space as an area that has one or more of the following characteristics:

1. Poor Ventilation: Air in a confined space does not move in and out freely. The atmosphere inside a confined space can be very different from the atmosphere outside. Dangerous gases may be trapped inside a confined space, especially if the space is used to store or process chemical or organic materials which may decompose. There may not be enough oxygen inside a confined space to support life. Similarly, the air could have so much oxygen that it is likely to increase the chance of fire or explosion if a source of ignition is present (a cigarette, for example).

2. Limited Entry and Exit Conditions: Many shipyard confined space openings are small in size. In some cases they may be as small as 18 inches in diameter which is difficult to move through easily. These small openings make it very difficult to get work equipment, protective equipment (respirators) and life-saving equipment in or out of these spaces. In some cases, confined space openings may be very large (i.e., open topped containers such as tanks or degreasers), but require equipment such as ladders or hoists to enter or exit these spaces. Escape from such areas may be very difficult in an emergency.

3. Not Designed For Continuous Worker Occupancy: Most confined spaces are not designed for workers to enter and work in on a routine basis. They are designed to store a product, enclose materials and/or processes, or transport products. Therefore, inspection, maintenance, repair, cleanup, etc., is often difficult and dangerous because of the chemical or physical hazards within the space.

If a confined space in the workplace has a combination of the three aforementioned characteristics, it can complicate working in and around these spaces, as well as complicating rescue operations during emergencies.

Examples of Confined Spaces

Confined spaces can be found in almost any kind of work place, especially shipyards. The following is a listing of areas that should be treated as confined spaces:

Storage Tanks, Boilers and Furnaces	Bilge Tanks	Compartments
Pumping Stations	Pipelines	Septic Tanks
Sewers	Vats	Blocks
Sewage Digesters	Pits	Ship Holds
Reaction Vessels	Silos	Utility Vaults
Pits	Trenches	Tubs/Vats

This list is not inclusive of all confined spaces that may be encountered in a shipyard.

Training Requirements for Confined Space Entry

Employer are required by law to provide training to all employees who work in confined spaces. This training must provide an employee with the knowledge and skills necessary for safe performance of the duties assigned. Confined space entry procedures require workers to be trained to use shipyard air monitoring instruments, lock/tagout procedures and various personal protective equipment ("PPE"). Training concerning equipment operation and PPE should include all procedures for use, as well as equipment inspection and maintenance. The program should outline the capabilities and limitations of the equipment to be used for characterizing and entering a confined space. Workers must also be trained to protect themselves from exposure to chemicals and physical hazards. Training should include the appropriate use of engineering controls, respirators, spark proof tools and other shipyard working practices. It must be understood that training is the only effective method of ensuring worker safety during confined space entries, especially in an emergency situation.

This training must be provided to each employee:

1. Before the employee is assigned duties related to the entry.
2. Before there is a change in assigned duties.
3. When there is a change in permit space operations that presents a hazard on which the employee was not previously trained.

4. When the employer has reason to believe that there are deviations from the permit space entry procedures, or that there are inadequacies in the employee's knowledge or use of the procedures.

This training shall establish employee proficiency in their duties and the employer must certify that the training has been completed by providing a certificate with the employee's name, the signature or initials of the trainers and the dates of the training.

Hazards in Confined Spaces

Prior to entering a confined space, shipyard emergency responders and/or workers must consider many types of hazards. The confined space must be characterized in such a way as to define the chemical and physical hazards associated with the area. Hazards associated with confined spaces may be atmospheric such as oxygen deficiencies, the potential for fire or explosion, chemical toxicity, or others that may cause asphyxiation or engulfment . A variety of mechanical hazards may also exist. Regardless of the type, emergency responders must be very aware of potential hazards during rescue operations. Nearly 66% of confined space deaths occur during rescue operations and most deaths are the rescuers.

Atmospheric Hazards In Confined Spaces

One of the key components to assuring employee safety while working in a confined space is to monitor for atmospheric hazards. An atmospheric hazard is any atmosphere that may cause death to an employee or cause the employee to become injured, acutely ill, incapacitated, or impair their ability to self-rescue. One or more of the following six (6) conditions can cause this to happen:

1. Flammable gas, vapor, or mist meets or exceeds 10% of the LEL.
2. The airborne combustible dust concentration that meets or exceeds the LEL concentration and obscures vision at 5 feet or less.
3. Atmospheric oxygen concentration is below 19.5% or above 23.5%.
4. The atmospheric concentration of any substance that exceeds the published PEL.
5. Any atmospheric condition that is Immediately Dangerous to Life and Health (IDLH)
6. Any condition that would pose an immediate or delayed threat to life, cause irreversible adverse health effects, or interfere with an individual's ability to escape unaided from the permit space.

Due to the lack of natural air movement, the most common confined space hazards are related to hazardous atmospheres (i.e. insufficient breathing air quantity or quality) which can result in:

1. Oxygen deficient and oxygen enriched atmospheres
2. The presence of combustible gases (flammable atmospheres)
3. The presence of toxic gases (toxic atmospheres)

1. Oxygen-Deficient and Oxygen Enriched Atmospheres:

Normal breathing air contains approximately 21% oxygen. An oxygen concentration of less than 19.5% is considered to be an oxygen deficient atmosphere and unsafe for entry without supplied air or SCBA. The oxygen level in a confined space can decrease because of the following:

- Production operations being performed, such as welding, cutting or brazing.
- Consumption of oxygen (combustion, decomposition of organic matter, oxidation, etc.).
- Certain chemical reactions (for example, rusting, oxidizing or through fermentation).
- Absorption of oxygen (caused by the vessel itself or the contents stored in it).

- Displacement of oxygen (intentional purging with inert gas to remove residual gases or vapors, or unintentional purging).
- Displacement of oxygen by another gas, such as carbon dioxide or nitrogen.
- Simple asphyxiates (which displace atmosphere oxygen), that add to the possibility of oxygen deficiency. Examples of simple asphyxiates are nitrogen, carbon monoxide and methane.
- Activated carbon will absorb oxygen and cause an oxygen deficiency.

An oxygen enriched atmosphere occurs when the oxygen level exceeds 21%. Oxygen is an oxidizer and the body cannot handle excess quantities. An enriched oxygen atmosphere can be caused by a leaking or unattended oxygen cylinder or air lines which create a serious fire hazard. Employees should never use pure oxygen to resolve a deficiency. Too much oxygen will initiate a fire, which may cause hair or clothing to ignite.

The following table illustrates oxygen levels which are acceptable and unacceptable.

	Deficient	Acceptable	Enriched
Oxygen Level %	< 19.5	> 19.5 to < 21	> 21

Employees should always test the atmosphere to determine oxygen percentage, remember that air purifying respirators do not supply oxygen, never work in oxygen deficient atmospheres unless air respirators are used, never work in oxygen enriched atmospheres where fire and explosion hazards exist and ensure that instruments are not poisoned by the atmosphere.

The number one cause of confined space deaths is oxygen deficiency. The lack of oxygen can have both subtle and detrimental effects on the body as demonstrated on the next page.

RELATIONSHIP OF OXYGEN CONCENTRATIONS TO DURATION OF EXPOSURE AND EFFECT

Concentration (%)	Duration	Effect *
20.8 %	Indefinite	Usual oxygen content of air.
19.5 %	Not stated	Recommended minimum oxygen content for entry without air supplied respirators 29CFR1910.134.
12-16 %	Seconds to minutes	Disturbed respiration, fatigue, faulty judgment, some coordination loss.
10-14 %	Seconds to minutes	Disturbed respiration, fatigue, faulty judgment, emotional upset, poor circulation.
6-10 %	Seconds	Nausea, vomiting, inability to move freely, loss of consciousness, followed by death.
Below 6 %	Seconds	Convulsions, gasping respiration followed by cessation of breathing, cardiac arrest, death in minutes.

* Effect-Warning properties of low oxygen are inadequate except to trained individuals. Most persons fail to recognize danger until they are too weak to self-rescue. Signs of low oxygen include increased rate of respiration and circulation. Both of these symptoms accelerate the onset of more profound side effects including loss of consciousness, irregular heartbeat and muscle twitching. Loss of consciousness and death can be sudden.

2. Presence of Combustible Gases (Flammable Atmospheres)

Flammable atmospheres are very important to consider in shipyards because of the abundancy of painting, solvent cleaning, frequent welding and cutting of steel. The following two elements make an atmosphere in a confined space flammable:

1. The amount of oxygen in the air
2. A specific mixture of flammable gas, vapor, or flammable dust

The hazard becomes serious when a source of ignition (i.e., electrical tool or welding) is present in a space containing combustibles. This combination will result in an explosion that can be devastating. If the air in a confined space is rich in oxygen (above 21%), clothing and hair will burn very quickly when ignited. Therefore, never use pure oxygen to ventilate a confined space. Only ventilate confined spaces with normal air.

3. Presence of Toxic Gases (Toxic Atmospheres)

Stored materials, material applications and material waste can cause toxic atmospheres in confined spaces. Hazardous products stored in a confined space can emit toxic fumes. Paints and other materials applied on the walls of confined spaces can give off toxic gases. When cleaning the tank or confined space walls, toxic gases can be given off by the substances being used. For example, in the removal of sludge from a tank, decomposed material can give off deadly hydrogen gas. Or, a toxic odor could emit from the removal of foulant growth from a tank.

Many shipyard processes and associated emissions also may cause toxic atmospheres in confined spaces. Examples of processes that emit toxins are welding, cutting, brazing, painting, scraping, sanding and degreasing. Emissions of these processes (liquids, vapors, gases, mists, solids and dusts) produced near a confined space may also cause a toxic situation if they enter the confined space causing build up on the floor.

The following situations can cause a toxic atmosphere:

- Hazardous material stored within a confined space
- Application of coatings, solvents or preservatives
- Decomposition of organic material which will displace and consume oxygen, as well as produce toxic gases such as methane, carbon dioxide, carbon monoxide and hydrogen sulfide.
- Toxic gases that enter a confined space from an outside source because of improper ventilation, etc. Two of the most common toxic gases found in confined spaces are hydrogen sulfide (H_2S) and carbon monoxide (CO).

Air Monitoring and Confined Space Characterization

Remember that some gases or vapors are "heavier" than air and will settle to the bottom of a confined space (**See Diagram**). Also, some gases are "lighter" than air and will be found around the top of the confined space. Therefore, it is important that a qualified person monitor all areas (top, middle, bottom) of a confined space for toxic gases and vapors before anyone enters. The oxygen level, flammability, known toxins or suspected toxic materials should always be monitored. Never trust human senses to determine if the air in a confined space is safe for entry! Workers <u>cannot</u> see or smell many toxic or flammable gases and vapors. Nor can workers determine the level of oxygen present. A confined space should be monitored continuously to determine whether the atmosphere has changed because of the work being performed.

If testing reveals oxygen deficiency, toxic gases and vapors, or flammable gases and vapors, the space must be ventilated and re-tested before unprotected workers enter. If ventilation is not possible and entry is necessary (for emergency rescue), workers must have appropriate respiratory protection, which usually requires Self Contained Breathing Apparatus (SCBA).

The following information represents some issues to consider when addressing confined space entry permit requirements.

GENERAL INFORMATION:	ISOLATION CHECKLIST:	HAZARDOUS WORK:
Location of the work site Description of work Employees assigned Entry date Entry time Outside contractors	Blanking and or disconnecting Electrical Mechanical Other	Burning Welding Brazing Open flame Other

HAZARDS EXPECTED:	VESSEL CLEANED:	PERSONAL SAFETY:
Corrosive materials Flammable materials Toxic materials Spilled liquids Cleaning (i.e.,chemical or water) Hot equipment Open drains Spark producing operations Pressure systems Other	Deposits Method Inspection Neutralized with	Ventilation requirements Respiratory protective equipment Protective clothing Head, hand and foot protection Shields Life lines and harnesses Lighting Communications Employee qualifications Buddy system Standby personnel Emergency egress procedures Training sign off (supervisor or qualified person

ATMOSPHERIC GAS TESTS:		
TESTS PERFORMED	**LOCATION**	**READING**
Oxygen		19.5%
Flammability		Less than 10% LEL
Toxicity		Less than PEL

Common Hazards Encountered In Confined Spaces For HazMat Teams

The most commonly encountered hazard in a confined space will be a toxic atmosphere. Oxygen deficient atmospheres, carbon monoxide and hydrogen sulfide are statistically the most common encountered confined space atmospheric hazards. However, in shipyard confined spaces, there is the possibility of other types of dangers.

These dangers include hazardous materials stored in tanks and piping systems. These can be corrosives, various cleaning products solvents, petroleum products, unknown products, or products that have gone through some form of chemical reaction by mixing with other chemicals or being subjected to heat. Any or all of these situations could pose both skin and respiratory threats to responders. Consideration must also be given to the modifying factors in the confined space, (i.e., build up of vapors, lack of air flow and ventilation, moisture, heat, etc.). Due to the potential build up

of vapors and ventilation factors within a confined space, only intrinsically safe and explosion proof portable lighting, atmospheric monitoring equipment, fans and other related equipment should be used during entry operations.

Other items to consider when responding to confined space emergency situations are fall and trip hazards. The use of head lamps and radio harnesses or in-suit communications can help free the hands of the responder for holding onto objects, climbing, crawling and being able to carry and use safety equipment such as ropes and atmospheric monitoring and sampling instruments. When wearing level-A or level-B PPE, it is easy to trip over hard to see obstructions, slip on slick surfaces or fall down an inclined surface. Having to work around scaffolding within a confined space is one situation that is typical in the industry. This can cause a variety of trip, slip and fall hazards for the HazMat responder. Depending on the situation, if climbing and/or working off of scaffolding is required, additional PPE, such as safety belts, may need to be considered.

Confined Space Program

OSHA requires shipyards to develop and implement a system for the preparation, issuance, use and cancellation of entry permits for confined spaces. The entry permit is a checklist used to record all safety steps that are taken before a worker enters a confined space. When completely filled out, the permit becomes a written approval for the work and assures workers and supervisors that all possible hazards have been evaluated and all necessary precautions have been taken to ensure worker safety. It is based on individual shipyard hazard identification and evaluation and is the instrument that internally authorizes a trained employee to enter the “permit-required” area.

A written permit entry program for routine work activities must address the following points:

1. Prevent unauthorized entry.
2. Identify and evaluate hazards before entry.
3. Develop and implement procedures and practices necessary for safe entry operations.
4. Provide, maintain and ensure proper training and use of all equipment needed for safe entry operations (i.e., retrieval system, communication systems, etc.).
5. Evaluate permit space conditions when entry operations are conducted.
6. Provide at least one attendant outside of the confined space for the duration of entry operations.
7. Provide a means for the attendant to respond to an emergency without the distraction from the attendant's responsibilities at any other site if multiple spaces are being monitored.
8. Identify the persons who have active roles in the entry operations, identify their duties and provide training for them.
9. Develop and implement procedures for summoning rescue and emergency services, rescuing entrants, providing necessary emergency services to rescued employees and preventing unauthorized personnel from attempting to rescue.
10. Develop and implement a system of preparation, issuance, use and cancellation of entry permits.
11. Develop and implement procedures to coordinate entry operations when employees of more than one shipyard are working simultaneously as authorized entrants.
12. Develop and implement procedures necessary for concluding the entry after operations have been completed.
13. Review and revise the permit anytime there has been any unauthorized entry into the permit space, a hazard has been detected that was not covered by the permit, an injury or near-miss has occurred during an entry, there has been a change in use or the

configuration of the confined space, or an employee has made a complaint about the effectiveness of the program.

14. Review the permit-required confined space program, within one year after each entry, revising as necessary, using retained canceled permit to ensure that employees are protected from permit space hazards.

Shipyard Confined Space Written Programs

Shipyards that have employees who enter permit required confined spaces must have a written program that outlines procedures for the following:

- Identifying and evaluating hazards before entry and throughout the operation
- Acceptable entry conditions for personnel
- Knowing when to use and how to use entry permits
- Isolating lines and spaces within permit required confined spaces
- Purging, inverting and flushing lines
- Ventilating confined spaces
- Providing barriers to protect entrants
- Preventing unauthorized entry
- Training personnel
- Using the permit system
- Evaluating the written programs on an annual basis

The shipyard must evaluate both the written program and permit system on an annual basis or when the shipyard believes that the written program is not protecting the workers adequately. Evaluation of the program can be performed by evaluating canceled permits.

Confined Space Entry Permit System

OSHA does not have a set format for permits. Shipyards can design their own permit as long as the proper information can be found on the permit. An entry permit must define the conditions under which the permit space may be entered, state the reason for entering the space and list the anticipated entry hazards. The permit has check-off blocks for all required actions so that no steps will be forgotten. The person responsible and designated for filling out the entry permit, verifying the information on it, endorsing it and canceling the entry permit is the entry supervisor. The duties of the entry supervisor include:

1. Know the hazards that may be faced during entry, including information on the mode, signs, symptoms and the consequences of exposure.
2. Verify that all tests have been conducted and that procedures and equipment specified by the permit are in place (i.e., all entries have been made on the permit), before endorsing the permit to allow entry.
3. Terminate and cancel the permit when:
   a) The entry operations covered by the permit are complete, or
   b) An unacceptable condition, in or near the permit space, arises.
4. Verify that rescue services are available and that the means for summoning them are operational.
5. Remove unauthorized personnel who enter or attempt to enter the permit space during operations.

6. Determine that entry operations remain consistent with the terms of the entry permit. This would occur when the responsibility for the entry operation is transferred and during intervals dictated by the hazards and operations being performed within the space.

For entries where the individual authorizing the entry does not assume direct charge of the entry, a list must be compiled. This designates eligible attendants, entrants and individuals who may be in charge of the entry. It will also establish the length of time that the permit remains valid.

The entry permit must identify the following:

1. The permit space to be entered.
2. The purpose of the entry.
3. The authorized duration of the entry permit.
4. The authorized entrants by name.
5. The authorized attendants by name.
6. The current supervisor by name with a space for signature or initials.
7. The measures used to isolate the permit space and eliminate or control hazards.
8. Acceptable entry conditions.
9. Initial and periodic tests performed (names of the testers and when the tests were performed).
10. The rescue and emergency services that can be summoned and the means of summoning.
11. The communication procedures to be used by entrants and attendants during entry operations.
12. The equipment to be used during the entry, including personal protective equipment, testing equipment, communications equipment, alarm systems and rescue equipment.
13. Any other information necessary, given the particular space, to ensure the safety of the entrants.
14. Any additional permits, such as hot permits, issued for work in the confined space.

The completed permit should be posted at the portal at the time of entry. The entry supervisor shall terminate the entry and cancel the permit when the entry operations covered by the permit are competed. Any problems during the entry must be noted on the permit. The canceled permit should be kept on file at the shipyard for at least one year. These canceled permits are to be used to review the confined space program and allow for changes and revisions.

Confined Space Supervisor and Attendants

The entry supervisor should ensure that all information found on the permit is accurate before he or she signs the permit approving work within a confined space. It is best for the supervisor to initial each required element on the permit . This will ensure that all elements of the permit have been checked.

The entry supervisor is to cancel the permit when the entry operation has been completed or when a condition that is not allowed under the entry permit arises in or near the permit space. Canceled permits are to be retained by the shipyard for at least one year beyond the date of issue. Any problems or conditions which arise during a permit space entry should be noted on the permit.

The shipyard is to designate an attendant to be stationed outside of the permit required confined space. Personnel assigned to duties as attendants should be motivated and well trained. Attendants should know the hazards that they will face during entry, including information on the mode, signs or symptoms and consequences of the exposure to dangerous atmospheres.

Attendants should be aware of the possible behavioral effects of exposure to hazardous atmospheres.

The duties of the attendant include:

- Continuously maintaining an accurate count of authorized entrants in permit required confined spaces and ensuring that only authorized personnel enter those spaces;
- Remaining outside the permit required confined space. The attendant is not to leave his or her duties until relieved by another authorized attendant;
- Communicating with authorized entrants, as necessary, to monitor entrant status and to alert entrants of the need to evacuate the space if conditions inside the space change;
- Ordering authorized entrants to leave the space immediately if any of the following are detected: presence of a prohibited condition; presence of a behavioral effect in any of the entrants from exposure to hazardous materials; a situation outside the space that could endanger the entrants; or if the attendant cannot perform all of the duties assigned to him/her;
- Summoning rescue and other emergency services during an emergency.
- Performing non-entry rescue of personnel within the space;
- Preventing unauthorized personnel from entering permit required confined spaces by: warning the unauthorized persons that they must stay away from the space; advising those persons that they must exit immediately if they have entered the permit space; informing authorized entrants and the entry supervisor if unauthorized personnel have entered the permit required confined space.

The shipyard may use one attendant for several permit required confined space operations, if that attendant can perform those duties without jeopardizing the safety of the authorized entrants. The attendant can enter the space to perform emergency rescues if: the attendant has been trained to perform those duties and has been provided with appropriate equipment including personal protective equipment and has been relieved as the attendant for the job operation by another qualified attendant.

Isolating Confined Space Hazards

In order to prevent injuries and accidents, confined spaces should be isolated to eliminate all hazards. Isolation is the process by which a confined space is removed from service and completely protected against the release of energy and material into the space by means such as:

1. Blanking or blinding
2. Mis-aligning or removing sections of pipe or ducts
3. A double block and bleeding the system
4. Lockout or tagout of all sources of energy
5. Blocking or disconnecting all mechanical linkages

Preventing Access/informing Workers

Once the permit required confined space has been identified, OSHA requires that the shipyard, or person controlling the property, inform workers of the hazardous confined space. Workers who work within the space, or within the area of the space, should be informed verbally of the hazard. In addition, the space should be marked with signs warning of the hazards at the entry point. Signs should read “DANGER, PERMIT REQUIRED CONFINED SPACE, DO NOT ENTER". If the space is easily accessed by workers, the shipyard should prevent workers from entering the space by locking the space, setting up barriers and/or posting a guard at the entrance.

Having signs at every possible confined space is very difficult to accomplish in a shipyard where there are so many confined space opportunities. All employees must be aware of their location and never proceed unless they are 100% sure that the space is not considered “confined”.

If Work Is To Be Performed In A Permit Required Confined Space

If work is to be performed within a confined space, the shipyard must either control the hazards within the space to protect the worker or provide the worker with adequate protective equipment to prevent him or her from injury or illness. Good industrial hygiene practice can protect the worker by controlling the hazard and providing a much safer work environment.

Permit required confined spaces should be evaluated thoroughly. Evaluation of spaces should include researching the work history of the space. The inspector should determine: what operations took place in the space; what materials were stored in the space; all detectable safety hazards present in the space and whether there are engulfment hazards or fall hazards within the space.

Once the investigator has an idea of what hazards may be present in the space, air monitoring should occur. Air monitoring should include measurements for oxygen content, combustible gases and vapors and the presence of toxic agents. Atmospheres should be tested in the order described above. Air monitoring should be tested initially and routinely throughout an operation to detect any change in conditions. Remember, disturbance of scale or residue in the confined space may change conditions rapidly. All tests should be documented on the work permit.

If the confined space contains a hazardous atmosphere, the best way to control the hazard is to provide continuous forced air ventilation. Forced air ventilation, including venturi blowers and grounded portable fans, can be used to blow clean air into, or exhaust contaminated air from, confined spaces. OSHA encourages shipyard to control hazardous atmospheres with ventilation. If forced air ventilation is used, the following should be adhered to:

- Workers may not enter the space until the hazardous atmosphere has been eliminated, as demonstrated by monitoring the air within the space.
- Ventilation shall be provided from a clean source and shall continue while the job is being performed within the space.
- The area in which the worker will be working will be provided with ventilation.
- The atmosphere shall be periodically tested during the job.
- If the atmosphere becomes hazardous, the worker will leave the space immediately and the space will be tested and inspected to locate the cause of the change. Only after the hazard has been eliminated, as verified by testing the air, shall workers reenter the space.

Local Exhaust Ventilation

Placing and using local exhaust ventilation within confined spaces can be a difficult task; here are some helpful tips:

- Ventilation should be from a grounded, spark-free, intrinsically safe blower designed for ventilating confined spaces.
- All blowers will have ducts. Don't forget that the duct must be grounded or made of non-spark producing material. Ducts must extend sufficiently to reach those areas where workers will be located.

- Ensure that the duct is placed into the space so the air inside will be mixed uniformly; this will aid in exhausting the air contaminants.
- Blowing air into a space will always be more effective than sucking or drawing contaminated air out of the space.
- Spaces that are large or those with large amounts of contaminant or product within them may not be ventilated effectively.

Shipyard HazMat Team Members Required To Respond To Confined Space Incidents

One of the most likely tasks required of the shipyard HazMat Technicians during the response to an emergency incident within a confined space, is the rescue of employees that are trapped and/or injured within a hazardous material environment. Any response to a hazardous material emergency has a degree of risk. The confined space involved HazMat incident possesses its own unique and specific hazards and risks to responding team members. There are specific requirements for shipyards who have designated personnel who respond for rescue purposes within a permit-required confined space. The following requirements apply to these shipyards:

1. The shipyard shall ensure that each member of the team is provided with and trained to properly use the PPE and rescue equipment necessary for making rescues within confined spaces.
2. Each member shall be trained to perform the assigned rescue duties.
3. Each member shall receive the same training required of authorized attendants.
4. Each member shall practice making permit space rescues at least every 12 months. This practice will consist of simulated rescue operations in which they remove dummies, mannequins or actual persons from representative permit spaces.
5. Each member shall be trained in basic first aid and in CPR, and at least one member of the team shall hold a current first aid and CPR card.

Example of a Confined Space Emergency Situation

Examine a situation where an employee entered a shipyard storage tank to remove, or clean-up, diesel fuel residues. The tank was approximately 20 feet tall, 15 feet wide and 10 feet in length. The shipyard rented a self-contained breathing apparatus (SCBA), for this entry and instructed the employee in its use. The employee had been provided with a length of rope for descent into the tank. The shipyard worker could not fit through the tank opening while wearing the SCBA, so the shipyard decided to lower the SCBA, using the same rope, once the employee reached the bottom of the tank. After entry, the shipyard lowered the SCBA; however, the employee collapsed before he could put it on. The tank atmosphere was not tested and no advance provisions for rescue were implemented. A call for help was sent to the local fire department. Due to the small opening, the firemen could not enter the tank while wearing the SCBA. It was decided that only by cutting the tank open could the victim be rescued. Despite precautions taken by the firemen cutting the tank, the diesel vapor in the tank ignited and exploded. The explosion killed one fireman and injured 16 others. It was later determined that the victim was already dead because of the toxic effects of toluene and a lack of oxygen before the explosion occurred.

This incident took place because the associated hazards of the confined space were not appreciated by the shipyard workers or would-be rescuers. Similarly, the proper confined space entry procedures were not followed.

A confined space permit program and permit system would have prevented the deaths and injuries cited in the above example. In this situation, the standard would require the shipyard to identify all

the serious hazards prior to entry and to train the employees in proper entry procedures. By so doing, the unsafe entry would not have been authorized. Also, if appropriate rescue provisions had been made, valuable time would have been saved and the worker could have been rescued without requesting help from the local fire department.

Having Rescue Services Available & Procedures to Summon

Shipyards that have personnel who perform permit required confined space entry should have rescue and emergency services available. Emergency services may include trained and qualified in-house personnel. OSHA encourages shipyards to have in-house response teams.

The following conditions apply to in-house confined space response teams:

- The shipyard is to ensure that team members are provided with and trained to use, personal protective equipment and rescue equipment;
- Each member is to be trained to perform assigned duties as both an authorized entrant and rescue team member;
- Each member of the rescue team shall practice making permit space rescues at least once every twelve months;
- Each member shall be trained in basic first-aid and in CPR.

Confined Space Rescue Planning

Over 60% of workers who die in confined spaces are trying to rescue other workers. Therefore, an appropriate standby and rescue plan is especially important for anyone working in a confined space. Rescuers must be trained in and follow established emergency procedures. They must also use proper equipment, such as respiratory protection. Steps for a safe rescue should be:

- Included in all confined space entry procedures,
- Established before entry,
- Specific for each type of confined space,
- Well-planned and practiced often enough to ensure an efficient and calm response to any emergency.

Unplanned rescues, such as when someone rushes in without ________ and can easily result in another death.

Confined Space Hazards and Risk Unique To HazMat Response

A HazMat incident within a confined space could be extremely physically and psychologically challenging to the HazMat Technician. Something as basic as gaining entry to the site of the HazMat area could involve having to gain access by ascending or descending a considerable distance, having to wear specialized safety gear, or having to crawl through small openings or passageways. All of this work may be completed wearing a level-A or level-B chemical protective suits. The wide range of sizes, construction and configuration of confined spaces found in shipyards present an equally wide range of challenges and risks for responding HazMat Technicians. Examples range from small vessels and simple piping systems, to large tanks and maze-like shipboard compartments.

Movement and Dexterity Restrictions: Any situation found in a confined space can be made more challenging and dangerous with the use of a level-A or level-B chemical protective suit. Chemical resistant gloves do a great job of keeping hazardous chemicals off the responders skin, but can severely reduce hand dexterity and grip. Wearing a leather work-glove over chemical resistant gloves to allow for better gripping should be considered if ascending or descending a ladder is

required. The same consideration for chemical resistant boots should apply. Make sure that boots worn by the HazMat Technicians have an appropriate sole.

Harness System Restrictions: Rope and harness systems might be required to lower rescuers into a confined space, or to raise them back out of it (i.e., having to perform a rescue into a pit, large storage tank, or other type of vessel). Care must be taken to choose the appropriate type and size of rescue harness that is compatible with chemical protective suits, finding a harness that is large enough to fit comfortably and safely over the suit and designed in a manner that will not abrade or rip the suit.

Crawling and Protective Equipment Damage: In most HazMat response scenarios, the HazMat technician is advised not to crawl and make ground-to-suit contact, to prevent abrading or ripping the chemical resistant suit. In some confined space situations, it would be impossible for the HazMat responder not have to crawl on their hands and knees. The use of well constructed knee and elbow pads that are made of materials compatible with the hazardous material encountered, is a vital component to the responder's personal protective equipment when entering low ceiling or restricted area confined space environments. Similarly, caution should be used when working around objects that could snag or tear the protective suit.

Supplied Air Vs. SCBA Restrictions: Most often, the HazMat Technician PPE will include a SCBA for level-A and level-B protection. Unfortunately, in many confined spaces, the entry to the space is through a very narrow and restrictive opening. This type of a restricted opening will prevent the use of a SCBA because of the added bulk of the SCBA cylinder on the responder's back. Removing the SCBA tank and placing it into the opening ahead of the responder and/or crawling through a narrow confined space while pushing the doffed tank <u>is not an accepted safe practice</u> for confined space entry. In this case, the need for a supplied air system becomes apparent. The supplied air system has benefits and drawbacks that include:

1. The supplied air system is a light weight and low profile system that allows for easy maneuvering within a confined space.
2. It has an "endless" capacity for delivering air as opposed to a 30, 45, **or** 60 minute SCBA bottle which can increase stay time. Care should be given, however, not to fatigue or heat stress the responder when using an air supply system that allows for extended stay time.
3. Without the weight of an SCBA bottle, the responder can reduce the physical burden and heat stress potential while using a supplied air system.
4. The air supply hose has a legal restriction of 300 feet.
5. There is a possibility of the air supply line getting snagged or damaged while being dragged through the confined space.
6. A 10 minute escape air pack must be worn when using a supplied air system.
7. A supplied air system is dependent on an air source being staged in the vicinity of the responder. A plan might have to be developed to address how the responder is going to reach the decontaminationtamination corridor (if beyond the length of the air supply line), when working off the top of an elevated vessel or down in a sub-level space and using a supplied air system. Arrangements might have to be made to raise or lower the air supply source with the responder to the level that the decontaminationtamination corridor is located. Disconnecting from the supplied air line and using the escape air pack to get through decontaminationtamination corridor are some of the options and considerations.

Radio Communication In Confined Spaces

Radio communications may be inconsistent while working in a level-A or level-B suit. It becomes an even a bigger challenge when putting the responder into a confined space. Metal and concrete barriers, found typically in confined space structures, can cause transmission problems from hand-held radios. Radio transmissions typically do not do well transmitting vertically (i.e., from a responder down inside a tank). Due to these complications, hard wire communications are best when dealing with confined space entry. There are a variety of hard wire communication systems available on the market for confined space operations. One must carefully choose the appropriate system to accommodate HazMat response. However, it is important to have back-up and alternate communication plans and systems when making a confined space entry. Do not rely solely on a radio system as your only means of communicating with your team. Radio communication systems have been known to fail, especially in confined spaces.

Victim Removal From A Confined Space

The task of removing an injured victim is hard enough under ideal conditions. Victim removal is made even more difficult when having to maneuver in tight spaces, negotiate steep and sharp angles with little leverage and working in bulky and cumbersome PPE. Another challenging factor in the rescue of victims from a confined space is that most victims are unconscious/unresponsive. Victims in this state generally offer no assistance to the rescuer and are in a state of complete muscle relaxation and have a lack of muscle tone ("dead weight"). Even a fairly light victim can be extremely difficult to hold on to and manage during rescue and retrieval. Strapping material or other rescue devices are required to assist the HazMat Technician. It may be necessary to utilize a rope and mechanical advantage system to extract the victim from the confined space. The bulkiness, lack of dexterity and restrictive movement of PPE will add to the challenge of utilizing a rope within the confined space. In general, the simpler the retrieval system, the better.

Retrieval systems shall meet the following requirements:

1. Each authorized entrant shall use a chest or full body harness, with a retrieval line attached at the center of the entrant's back near the shoulder level, or above the entrant's head.
2. Wristiets may be used if the shipyard can demonstrate that the use of a full body harness is not feasible or creates a greater hazard and that the use of the wristiets is the safest and most effective alternative.
3. The other end of the retrieval line shall be attached to a mechanical devise or a fixed point outside the permit space in such a manner that a rescue can begin as soon possible.
4. A mechanical devise shall be available to retrieve personnel from vertical type spaces more than five feet deep.

Heat Stress Considerations In Confined Spaces

Careful consideration must be given to the level of chemical protective clothing to be used for entry into a confined space. The danger of heat stress while wearing chemical protective clothing is magnified when working in a confined space. This is because of the added physical and psychological stress of working in this unique, dangerous and physically challenging environment. The use of level-A or level-B suits needs to be carefully weighed against the risk of the hazardous material in question and the physical well-being and safety of the responder. Though it is universally agreed that a level-A suit offers the responder the maximum vapor protection, other factors must be considered before the HazMat responder enters a confined space (heat stress, psychological stress,

mobility, etc.). Chemical identification and hazardous assessment, along with common sense, will be required to make the best judgment on suit selection in relation to overall responder safety. If utilizing a supplied air system, careful monitoring of time-in and the ongoing assessment of the status of the responders in the confined space is paramount to assuring their safety.

Remember.- An unplanned rescue will probably be your last.

Case Reports of Confined Space Deaths

The following are several actual cases of worker and rescuer deaths that occurred in a variety of confined spaces. These cases were reported by NIOSH in a 1986 ALERT titled "Request for Assistance in Preventing Occupational Fatalities in Confined Spaces." With this report, NIOSH requested the assistance of managers, supervisors and workers in the prevention of deaths that occur in confined spaces. Had the confined spaces in these reports been properly evaluated prior to entry, continuously monitored while the work was being performed and had appropriate rescue procedures, none of these deaths would have occurred. More than 60% of confined space deaths occured among would-be rescuers. Therefore, a well designed and properly performed rescue plan is a must.

Oxygen deficiency case On December 29, 1983, a 54-year-old worker died inside a floating cover of a sewage digester while trying to restart a propane heater. The heater was being used to warm the outside of the sewage digester cover prior to painting. Workers wired the safety valve open so that the flow of propane would be constant, even if the flame went out. The heater was located near an opening in the cover of the digester. When the worker tried to restart the heater, an explosion blasted through the opening. The worker crawled away from the heater into an area that was oxygen deficient and died. A co-worker tried a rescue and also died.

Toxic atmosphere/physical hazard case On March 8, 1984, a 20-year-old construction worker died while trying to refuel a gasoline engine powered pump that was being used to remove wastewater from a 66-inch diameter sewer line that was under construction. The pump was about 3,000 feet from where the worker had entered the line. The worker passed out from carbon monoxide. A co-worker, who had also entered the sewer line, escaped. A 28 year old state inspector entered from another point along the sewer line and died in a rescue attempt. In addition to the deaths, 30 firefighters and 8 construction workers were treated for carbon monoxide exposure.

Oxygen deficiency case On October 4, 1984, two workers died after rescuing another worker from a fracturing tank at a natural gas well. The tank contained a mixture of mud, water and natural gas. The rescued worker was going to move a hose from the tank to another tank. The hose was attached by a chain and when the worker moved the hose, the chain fell in the tank. The worker entered the tank to get the chain and passed out. After the other two workers rescued him, they passed out because of gas vapors and drowned.

Toxic atmosphere/explosion/limited entry and exit case On December 5, 1984, a 22-year-old worker died inside a toluene storage tank while cleaning the tank. The tank was 10-feet in diameter and 20-feet high. The worker entered the tank through the 16 inch diameter top opening using a half-inch rope to lower himself. Although he had a self-contained breathing apparatus, the worker was not wearing it when he entered the tank. The worker passed out and collapsed on the floor of the tank. In an attempt to rescue the worker, firefighters began cutting an opening into the side of the tank. The tank exploded, killing a firefighter and injuring 15 others.

Physical hazard/toxic atmosphere case On July 5, 1985, a 27-year-old sewer worker entered an underground pumping station by a fixed ladder inside a three-foot diameter shaft. The work crew was unaware of procedures to isolate the work area and ensure that the pump had been bypassed. Therefore, the transfer line was still under pressure, and when the workers removed the bolts from a plate that covered the valve, the force of the wastewater blew the plate off. The sewage flooded the chamber and trapped one of the workers. A co-worker, a supervisor and a policeman attempted to rescue and died. The first two deaths appeared to be because of drowning. The latter two appeared to be because of asphyxiation as a result of the inhalation of "sewer gas."

Toxic atmosphere case On June 7, 1985, a father died while trying to rescue his son from a tank used to store waste acids from a metal pickling process. The tank was out of service so that the sludge could be removed from the bottom. The son collapsed in the tank. The father tried to rescue him and also collapsed. When the two were removed from the tank, the son was revived, but the father died. The cause of death is unknown.

Toxic atmosphere/physical hazard case On May 13, 1985, a 21-year-old worker died inside a waste water holding tank that was four feet in diameter and eight-feet deep. The worker was cleaning and repairing a drain line. Sulfuric acid was used to unclog a floor drain leading to the holding tank. The worker collapsed and fell face down into six-inches of water in the bottom of the tank. A second worker attempted a rescue and also collapsed. The first worker was pronounced dead at the scene, the second worker died two weeks later. Cause of death was believed to be asphyxiation by methane gas. Sulfuric acid vapors may have also contributed to the cause of death.

Based on the information from these case studies, NIOSH concluded that these deaths occurred as a result of one or more of the following potential hazards:

1. Lack of natural ventilation
2. Oxygen deficient atmosphere
3. Flammable/explosive atmosphere
4. Limited entry and exit
5. Dangerous concentrations of air contaminants
6. Physical barriers or limitations to movement
7. Instability of the stored product

In each of these cases, there was not enough of one or more of the following:

- Identification of the confined space
- Atmosphere testing/monitoring before and during entry
- Ventilation
- Use of proper isolation procedures
- Respiratory protection
- Adequate rescue/standby plan

Session 7. Recognition of Hazardous Substances

Recognition and identification of hazardous substances is a key element for an organized, safe and effective emergency incident response. A situation that can cause serious harm is inevitable if an emergency responder does not recognize that hazardous materials are involved. Once recognized and identified, the responders can initiate the appropriate response. The following list describes several key hazardous materials recognition clues:

- Location of hazardous materials and waste in the shipyard (Plating shop, garage, machine shop, or Haz-waste areas)
- Container Shapes and Substance Forms (55 gallon drums, plastic jugs, liquids, solids, etc.)
- Markings & Colors (Package/label markings or colors)
- NFPA and DOT Placards & Labels (Orange placard = Explosive)
- Shipping Papers (if material is in transport)
- MSDS (Hazcom MSDS books located nearby)
- Senses (Sight, hearing and smell - last resort)
- Awareness of what people are doing (people could be running from the scene or collapsed in the area)
- Other Clues (responsible party, witness, business plan, etc.)

Remember to always assume that there are hazardous materials present and look for clues or warning signs until you confirm the absence of hazardous materials.

Shipyard Hazardous Locations

This applies chiefly to shipyard areas and buildings that may contain hazardous materials and/or wastes. These areas could include manufacturing, metal processing, painting operations, hazardous materials storage areas, maintenance and machine shops. While many locations are obvious repositories of hazardous materials, other locations are more subtle. For example, there can also be hazardous materials in the photo-labs, engineering departments, and other support areas that may not be intuitively associated with hazardous materials. These areas should be clearly marked by signs and placards, and should be included in the shipyard hazardous materials business plan.

Hazardous Substance Forms and Associate Container Types

Responders must have a good understanding of the variety of shipyard hazardous substance forms and associated containers. This will enable the responder to determine if a hazardous substance is involved with the incident and provide a better understanding of the hazardous condition. Proper chemical recognition and identification will provide valuable information about attending to the chemical exposure and spill clean-up.

A hazardous substance may take the form of a solid, liquid or gas. As a substance is cooled or heated it may change from one form to the other. The hotter the workplace environment (or the more heat used in the process), the more a liquid or solid will evaporate, or otherwise give off harmful fumes and vapors. This is very important when there is a potential for fires or explosions. The following table illustrates various shipyard substances, their forms and potential container types:

Substance Forms	Shipyard Hazardous Substance Example	Example Potable Container Types
Solids	Cyanide, Grit, Paint Solids, Production Dust, Fiberglass, Welding Fumes	Hazardous solid substances generally are packaged in high performance bags, boxes, and cans/jars (plastic and metal).
Liquids	Paints, Solvents, Acids	Hazardous liquid substances generally are packaged in metal cans (1 to 5 gallons), 55 gallon drums (plastic and metal), and a variety of plastic, metal or glass jars.
Vapors & Gases	Welding Gases, Welding Fumes, Aerosols	Hazardous gases are packaged in high performance pressurized cylinders from 5 to 500 pounds in weight.

Note: All types of materials, especially hazardous gases and liquids can be stored in large permanent tanks.

1. Solids: Solids most dangerous to your health are dusts, fibers, and fumes. These types of solids are so small, they can be inhaled directly into the lungs, where they may damage the lungs, or pass into the bloodstream to harm other parts of the body.

Solid Type	
Dusts	Solid particles made by handling, crushing, or grinding materials such as rock, metal, coal, wood, or grain. Any process that creates dusts in the air should be considered hazardous until industrial hygiene testing proves it safe.
Fibers	Dust particles whose shape is long and narrow, rather than rounded. If the length is three or more times the width of a particle, it is called a fiber. The most well known fiber in the industry is the *asbestos* fiber.
Fumes	Tiny solid particles produced by heating metals. Fumes are produced mainly in industrial high-heat operations, like welding, melting and furnace-work. Fumes are often mixed with hazardous gases, like ozone and nitrogen oxides, which are taken in by the lungs at the same time. Aerosol is the general term for any airborne particle, whether solid or liquid.

Note: Particle size is important in determining how harmful a particle is to your health. Particles range in size from 0.1 to 25 micrometers. Only particles less than five micrometers stay suspended in the air long enough to be inhaled. These fine particles cannot be seen without a microscope, but they are the most dangerous to your health because they penetrate into your lungs.

2. Liquids: Hazardous liquid containers are used, stored and transported throughout the shipyard, posing a continuous threat of spillage and personal contamination. Liquids can splash or spill onto people and into the environment. They can also enter the body through all three exposure routes (ingestion, dermal, and inhalation). Liquids are used in large quantities at shipyards and pose a significant threat to human exposure as well as potential environmental releases to lakes, rivers, and bays.

3. Vapors & Gases: A vapor is the technical name for the gaseous form of a liquid. Vapors are generated from the surface of a liquid. The closer a liquid is to its boiling point, the more it vaporizes. Liquids with boiling points just above room temperature vaporize readily, and are called volatile.

A gas is a fluid that expands quickly to fill the space that contains it. In other words, gases will expand and seek to take up more area and become less concentrated. Many gases are highly flammable and reactive, both chemically and within the body. Some gases, such as those for welding operations, are contained in pressurized cylinders throughout the shipyard. These containers pose significant risk to human safety and to the environment during an emergency incident. If a compressed gas cylinder is in the immediate area to an incident, it adds an extra

element of risk. Compressed gas cylinders have the potential of rapidly releasing the gas, which can project the heavy cylinder like a torpedo.

When Hazardous Materials Are Recognized, The First Thought is SAFETY

Once a hazardous material or waste is recognized from identifying the label and container, the responder must think safety with every breath they take. It is very important to think safety first, last and always. When hazardous materials are present in an emergency situation, the risk to human health and safety is increased significantly. Once a hazardous substance has been identified, the responder must use a “go slow approach”. A quick and unplanned response can kill or injure the Operational Responder and others in the area. Always maintain a "Positive Safety Attitude”. Negative safety attitude responders think that safety precautions are overkill, which frequently results in injury and even death for the responder and others.

Maintain a Positive Safety Attitude

- Use recognized safety procedures via vigilance and discipline.
- Develop awareness of possible secondary and tertiary hazards.
- Treat all HazMat events with respect and anticipate problems.
- Cross reference 3 or more sources before action planning.
- Ensure back-up plans are in place for failure of safety devices.
- Maintain a "Mental Safe Approach Tactic" while on-scene.
- Always keep your distance until the Hazards have been fully identified (Upwind, Upgrade, Upstream).

Remember the Six Ways a Hazardous Material Can Kill You!

1. Toxicity
2. Radioactivity
3. Asphyxiation
4. Explosion
5. Combustibility/Flammability
6. Corrosion

Hazardous Container Labels

All containers of hazardous chemicals that enter the shipyard must have a label. The label is the primary source of information regarding the hazards of a chemical. The first time a person handles a chemical, and whenever a significant period has passed since the information has been reviewed, the detailed precautionary information on the label should be examined. This information includes:

- What The Hazards Are
- How To Avoid The Hazards
- How To Recognize Exposure
- What To Do In Case of Exposure
- How To Handle Spills and Accidents

In the event of a spill or personal chemical exposure, it is imperative that the Operational Level Responder know the type and nature of the chemical involved. A proper chemical label will provide the necessary information to clean-up the spill, or attend to the chemical exposure (i.e., wash eyes with water).

Five (5) Main Types of Labels and Placards

There are five main types of labeling systems used to identify potentially hazardous substances and the specific hazards they present. The five types of labels and placards are listed below:

1. American National Standards Institute (ANSI)
2. Hazardous Material Information System (HMIS)
3. Military System
4. National Fire Prevention Association (NFPA)
5. Department of Transportation (DOT) Hazard Class Marking

While the first three types of labeling are important, they are not discussed in as much detail as the NFPA system of labeling and placarding or the DOT hazard class marking system.

1) American National Standards Institute (ANSI)

The ANSI label mainly uses words to communicate information. It lists the physical and health hazards, including the target organ effects. The level of hazard and Signal Word is printed on the upper left side of the label. The signal words and their meaning are:

- ***DANGER*** Serious hazard
- ***WARNING*** Less hazardous but still severe
- ***CAUTION*** Moderate hazard but still of concern

The "Signal Word" alerts the person using the chemical to the level of the hazard associated with using the material. The choice of signal word depends on the nature of the hazardous substance, its concentration, and the degree of harm exposure will cause. The responder must understand the "Signal Word" because it will be the most visible information on the chemical container label. For example, when used to identify FIRE HAZARDS, the Signal Word has the following meanings:

Signal Word! / Example	STATEMENT OF HAZARD	FLAMMABILITY LEVEL
DANGER! / Gasoline	EXTREMELY FLAMMABLE	Flash-point below 20^{o}F
WARNING! / Toluene	FLAMMABLE	Flash-point between 20^{o}F and 100^{o}F
CAUTION! / Diesel Fuel	COMBUSTIBLE	Flash-point between 100^{o}F and 200^{o}F

Persons identifying hazardous substances should always identify the **"Signal Word"** and **the "STATEMENT OF THE HAZARD".**

TYPICAL STATEMENTS OF HAZARD	
MAY BE FATAL IF SWALLOWED HARMFUL IF SWALLOWED MAY BE FATAL IF INHALED MAY BE FATAL IF ABSORBED THROUGH SKIN HARMFUL IF INHALED MAY CAUSE ALLERGIC RESPIRATORY REACTION CAUSES SEVERE BURNS	EXTREMELY FLAMMABLE CAUSES IRRITATION CAUSES SKIN ALLERGIC REACTION HIGHLY VOLATILE CONTACT WITH WATER MAY CAUSE FIRE POWERFUL OXIDIZER

2) Hazardous Material Information System (HMIS)

The HMIS labeling system provides the degree of hazard of a chemical under normal usage conditions. The HMIS label lists the chemical name, health hazard, flammability, reactivity, and personal protective equipment. As in the NFPA labeling method, a number from zero to four represents the degree or severity for the hazard. Letters illustrate the recommended personal protective equipment.

3) Military System

The military system, like the NFPA system, is specifically designed to address fixed locations. It is generally used on military installations, and not in transportation. The emergency responder should be familiar with the details of this system if they have a Department of Defense installation within their jurisdiction.

4) National Fire Prevention Association (NFPA)

The NFPA 704 labeling system is intended to convey hazard information concerning chemical products to fire fighters and other emergency responders. The NFPA uses four-color coded diamonds to communicate the hazards with numbers that represent the degree of hazard.

The NFPA system is a nationally recognized method of indicating the presence of hazardous materials at commercial, manufacturing, institutional and other fixed facilities. The system displays the general hazards and degree of severity of toxicity, flammability reactivity and also indicates special information regarding the material(s).

This standard provides a simple system of readily recognizable and easily understood markings. Markings will give an at-a-glance general idea of the inherent hazards of the material and the order of severity of these hazards as they relate to fire prevention, exposure and control. The objectives are to provide an appropriate signal ,or alert, and on-the-spot information to safeguard the lives of fire fighting personnel during an incident. This system identifies the hazards of a material in terms of three principal categories: Health, Flammability, and Reactivity (Instability). Within these categories, an order of severity is indicated numerically by five divisions ranging from "FOUR", indicating a severe hazard, to "ZERO" indicating no special hazard.

A four-color coded diamond is used to communicate the hazards as shown below:

- The left quadrant (BLUE) indicates **HEALTH**.
- The top quadrant (RED) indicates **FLAMMABILITY**.
- The right quadrant (YELLOW) indicates **REACTIVITY or INSTABILITY**.
- The bottom quadrant (WHITE) indicates **SPECIAL INFORMATION** also any **REACTIVITY WITH WATER**.

Left/Blue Quadrant HEALTH HAZARDS :

Any property of a material that directly or indirectly cause injury or incapacitation, temporarily or permanently, from exposure by contact, inhalation or ingestion is outlined in this section.

Degrees of Hazard

Rating	Description
Four (4)	Short exposure could cause death or major residual injury regardless of medical treatment. **SPECIAL PROTECTIVE CLOTHING WILL BE REQUIRED, NO SKIN SURFACE EXPOSED FULL FIREFIGHTER'S PPE - SCBA - WRIST AND PANT LEGS BANDED**
Three (3)	Short exposure could cause serious temporary or residual injury, even with prompt medical treatment. **NO SKIN SURFACE EXPOSED, FULL FIREFIGHTER'S PPE - SCBA - WRIST AND PANT LEGS BANDED**
Two (2)	Intense or continued exposure could cause temporary incapacitation or residual injury.

	FULL FIREFIGHTER'S PPE AND SCBA
One (1)	Exposure would cause irritation but only minor residual injury, even if medical treatment were not received.
Zero (0)	Exposure under fire conditions would offer no hazard beyond that of ordinary combustible material.

Top/Red Quadrant FLAMMABILITY HAZARDS :

This section deals with the degree of susceptibility of materials to burning. Many materials that burn under one set of conditions will not bum under others. The form or condition of the material as well as its inherent properties affect the hazard.

Degrees of Hazard

Rating	Description
Four (4)	Materials that will rapidly or completely vaporize at atmospheric pressure and normal ambient temperatures.
Three (3)	Liquids and solids that can be ignited under almost all ambient temperature conditions.
Two (2)	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.
One (1)	Materials that must be preheated before ignition can occur.
Zero (0)	Materials that will not bum when exposed to a temperature of 1,500^{o}F.

Right/Yellow Quadrant REACTIVITY (INSTABILITY) HAZARDS :

This section deals with the degree of susceptibility of materials to release energy. Some materials are capable of rapid release of energy by themselves, as by self-reaction or polymerization, or can undergo violent eruptive or explosive reaction, if contacted with water, or other extinguishing agents and certain other materials.

Degrees of Hazard

Rating	Description
Four (4)	Materials are readily capable of detonation, or of explosive decomposition, or explosive reaction at normal temperatures and pressures. **USE HEAVY STREAMS FROM PROTECTED REMOTE LOCATIONS EVACUATION MUST BE ACCOMPLISHED**
Three (3)	Materials that are capable of detonation, explosive decomposition or explosive reaction, however, require a strong initiating force or must be heated under confinement before initiation. **FIRE FIGHTING SHOULD BE PERFORMED FROM AN EXPLOSION RESISTANT LOCATION**
Two (2)	Materials that are normally unstable and readily undergo violent chemical change but do not detonate. **FIRE FIGHTING SHOULD BE PERFORMED FROM A SAFE AND PROTECTED LOCATION**
One (1)	Materials which are normally stable but can become unstable at elevated temperatures and pressures. **CAUTION MUST BE USED IN APPROACHING THE FIRE AND APPLYING WATER**
Zero (0)	Materials which are normally stable, even under fire conditions.

Bottom Quadrant SPECIAL INFORMATION QUADRANT

The bottom quadrant of the NFPA diamond is used to indicate unusual reactivity with water. This space also may be used to indicate other additional information. Such as:

- Pressure vessels
- Radioactivity
- Proper fire extinguishing agent
- Appropriate protective equipment for fire fighting personnel

Example Symbols in the Bottom Quadrant

RADIOACTIVE
WATER REACTIVE
OXY = OXIDIZER
CORR = CORROSIVE
C = CONTAIN RUN-OFF

Deficiencies with the NFPA 704 System

Placards do not indicate:	Placards may be obscured:
The name of the material. The quantity of the material. The exact location of the material within the building.	At night. By smoke. By fog.

5) Department of Transportation (DOT)

DOT labels are diamond shaped and are usually present on containers and vehicles for transportation purposes. Colors and symbols that are used to represent the hazards are presented in the following table:

HAZARD	COLOR (SYMBOL)
EXPLOSIVE	ORANGE (BURSTING BALL)
GASES	GREEN (BOTTLE)
FLAMMABLE LIQUID	RED (FLAME)
FLAMMABLE SOLID	RED STRIPED (FLAME)
NON-FLAMMABLE GAS	GREEN
OXIDIZER	YELLOW (FLAMING "O")
POISON OR TOXIC	WHITE (SKULL AND CROSSBONES)
RADIOACTIVE	YELLOW & WHITE (RADIOACTIVE SYMBOL)
CORROSIVE	BLACK & WHITE (TEST TUBE)
MISC. HAZMATS	BLACK & WHITE (VERTICAL STRIPES)

Hazard Classes and Divisions

The "hazard class" of any particular hazardous material is indicated by its class or division number and its class name. The hazard class or division is required on the shipping paper and it is also used to determine placarding, marking and other labeling requirements. The following table describes the hazard classes, their placard color, and the NAERG96 Guide #.

Class/Division	Division Name	Placard Color	Guide #
1.1	Explosives (mass explosion hazard)	Orange	112
1.2	Explosives (projection hazard)	Orange	112
1.3	Explosives (predominantly a fire hazard)	Orange	112
1.4	Explosives (no significant blast hazard)	Orange	114
1.5	Very Insensitive Explosives; Blasting Agents	Orange	112
2.1	Flammable Gas	Red	118
2.2	Non-Flammable Compressed Gas	Green	121
2.3	Poisonous Gas	White	123
3.0	Flammable & Combustible Liquid	Red	127 / 128
4.1	Flammable Solid	Red/White Stripes	134
4.2	Spontaneously Combustible Material	White/Red Half/Half	136
4.3	Dangerous When Wet Material	Blue	139
5.1	Oxidizer	Yellow	143

5.2	Organic Peroxide	Yellow	148
6.1	Poisonous Materials	White	153
6.2	Infectious Substance (Etiologic Agent)	White	158
7.0	Radioactive Material	White/Yellow	163
8.0	Corrosive Material	White/Black	153
9.0	Miscellaneous Hazardous Materials	White/Black Striped	171

The Dangerous Placard

Dangerous placard usage requires at least 1001 pounds (454 kilograms) gross weight of two or more categories of hazardous materials. Therefore it is very difficult to determine the actual contents of a shipment with a dangerous placard.

A freight container, unit load device, motor vehicle, rail car which contains non-bulk packaging, with two or more categories of hazardous materials, typically requires different placards for each material. In this instance, however, the containers may be placarded with an all encompassing term, DANGEROUS. However, when 5000 pounds (2,368kg) or more of one category of material is loaded at one loading facility, the placard specified for each category must be applied.

The following information will provide the definitions, hazards and an example of each placard for each of the nine hazard classes.

Hazard Class 1: Explosives

Definition: Any substance or article, including a device, which is designed to function by explosion (extremely rapid release of gas and heat).

1.1 - Mass detonating
1.2 - Mass detonating with fragments
1.3 - Fire Hazard with minor blast or projectile hazard
1.4 - Substances which present no significant hazard
1.5 - Very insensitive explosives
1.6 - Extremely insensitive explosives

Examples: Dynamite, Nitroglycerine, Lead Azide, Detonators, and Black Powder
Hazards: Blast pressure (shock wave) and fragmentation hazard, possibly causing severe structural damage, fires, and thermal injury.
Comments: The six divisions in Hazard class I produces approximately 35 different placards.

Hazard Class 2: Gases

Definitions:

2.1 - Flammable gas: Ignitable at low concentrations (<13%)
2.2 - Non-flammable gas: Shipped at >41psi
2.3 - Poisonous gas: Toxic to humans or hazardous to health (or LC50 of not more than 5000 ml/m3 for laboratory animals, i.e. toxic in low concentrations).

Examples:

2.1 - Methane, Propane, Butane, Acetylene
2.2- Oxygen (when shipped as a gas), Anhydrous Ammonia
2.3- Cyanogen, Hydrocyanic Acid Phosgene

Hazards:

2.1 - Fire and explosion hazard, corrosive, toxic, unstable
2.2 - Can be corrosive, toxic or oxidizer, some can burn (NH3)
2.3 - Can cause illness injury or death, corrosive, flammable or explosive

Hazard Class 3: Flammable and Combustible Liquids

Definitions:

3.0 - Flammable Liquid: Flash Point <141^{o}F
Combustible Liquid: Flash Point > 141^{o}F (100 - 200^{o}F for domestic shipments)

Examples: Acetone, Benzene, Octane, Ethyl Alcohol, Diesel, Fuel Oil, Solvents

Hazards: Fire, Container Failure

Hazard Class 4: Flammable Solids

Definitions:

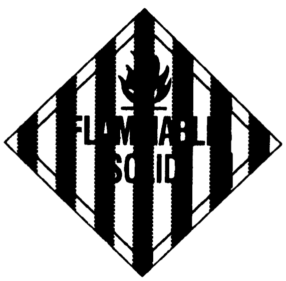
4.1 - Flammable Solid: Explosives shipped with sufficient wetting agent to suppress explosive properties. Self-reactive materials: Readily combustible solids which may cause fire through friction

4.2 - Spontaneously Combustible/Pyrophotic Liquid: Can ignite if in contact with air < five minutes

4.3 - Dangerous When Wet: Substances: Give-off flammable or toxic vapors or is spontaneously flammable upon contact with water

Examples: Pyroxylin Plastics, Magnesium, phosphorus, Metalic Sodium, Potassium, Calcium Carbide

Hazards: Flammable - some spontaneously, may be water reactive, toxic and/or corrosive; may be extremely difficult to extinguish.



Hazard Class 5: Oxidizers and Organic Peroxides

Definitions:

5.1 - Oxidizer: A substance that yields oxygen readily and sustains fire.

5.2 - Organic peroxide: Any organic compound containing oxygen in the bivalent structure which may be considered a derivative of Hydrogen Peroxide.

Examples:

5.1 - Aluminum Nitrate, Ammonium Permanganate, Liquid Oxygen, Hydrogen Peroxide

5.2 - Benzoil Peroxide, Urea Peroxide

Hazards: Supports combustion, may be unstable, and can be toxic and/or corrosive

Comments: Organic Peroxides are generally more dangerous than materials requiring the Oxidizer placard and can detonate.

Hazard Class 6: Poisonous and Infectious Substance

Definitions:

6.1 - Poisonous Materials: A material, other than a gas, which is known to be so toxic to humans as to afford a hazard to health during transportation.

6.2 - Infectious Substances (Etiologic Agent): A viable microorganism, or its toxin, that causes or may cause a disabling or fatal disease in humans or animals. Any other agent that causes or may cause a severe or disabling or fatal disease.

Examples:
6.1 - Aniline, Arsenic, Methyl Bromide
6.2 - Anthrax, Botulism, Rabies, Tetanus

Hazards: May cause illness, injury or death when inhaled, ingested, or absorbed into the body.

Hazard Class 7: Radioactive Material

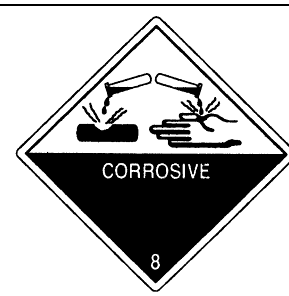
Definition: Substance with specific activity >0.002 microcuries per gram. Any material emitting radiation capable of penetrating and damaging living tissue.

Examples: Plutonium, Cobalt, Uranium Hexafluoride, Thorium.
Hazards: Exposure may cause radiation burns, illness, cancer, and even death. Fire may produce irritating or poisonous gases.
Comments: There are three labels which radioactive materials are transported under: I, II, and III. Radioactive III label shipments are the only ones requiring a placard.

Hazard Class 8: Corrosive Material

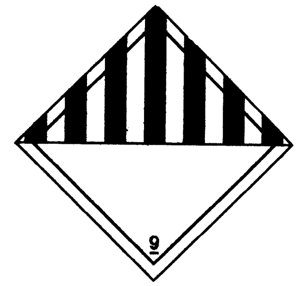
Definition: Substances that cause visible destruction or irreversible alterations in human skin tissue or a liquid that has a severe corrosion rate on steel or aluminum.

Examples: Acetic acid; Sulfuric acid; Potassium hydroxide; Nitric acid.
Hazards: Can cause severe chemical bums; respiratory distress; extensive tissue damage; may be explosive, oxidizer, flammable, toxic, unstable and/or water reactive.



Hazard Class 9: Miscellaneous Hazardous Material

Definition: A material which presents a hazard during transportation but which does not meet the definition of any other hazard class. It includes any material which has anesthetic, noxious, or other similar property which could cause extreme annoyance or discomfort to a flight crew, so as to prevent the correct performance of their duties.



ORM-D - A material such as a consumer commodity, which, although otherwise subject to the regulations, presents a limited hazard during transportation due to its form, quantity and packaging.

Examples: Polychlorinated Biphenyl's, Lithium batteries, Butane filled cigarette lighters, some hazardous wastes
Hazards: Do not underestimate the hazards associated with the materials transported under this class. They can range from flammable to toxic and corrosive.

Department of Transportation Shipping Papers

A critical document to aid the emergency responder at a transportation incident involving hazardous materials is the shipping paper. Each mode of transportation has its own title for the document, but all contain the same information as required by regulation.

The shipping description of a hazardous material on the shipping paper must include:

- Proper shipping name
- Hazard classification
- Four-digit identification number
- Packing group
- Type of package
- Total quantity of material by weight or volume

Certain commodities will require additional shipping paper entries. The letters "RQ" (reportable quantity), must be shown before or after the basic shipping description entry if the material is a hazardous substance, as defined by EPA. Any release of a material above its "RQ" must be reported to the National Response Center.

Session 8. Toxicology for the HazMat Technician

The toxicity of hazardous material at an incident is a critical factor in the decision made for a proper response. A number of questions must be asked and answered when the toxicity of the materials involved are evaluated. Some questions responders must ask are:

- Is a toxic material evacuation necessary?
- How much material evaluation is necessary?
- What are the risks to responders if entry is made?
- Are survivors possibly in the exclusion zone without protection?
- Which level of protection is necessary?

These questions are only a sample of the concerns that responders must have about hazardous substances in an emergency situation. Only an accurate evaluation of toxicity will enable a responder to answer key questions. Therefore this session provides an introductory understanding of toxicology, which is very important for the shipyard HazMat Technician Level Responder.

The History of Toxicology

Toxicology is the branch of science that studies poisons and their effects. The earliest toxicologists, in their struggle for survival, divided all substances into two categories: foods or poisons. Poisons were those materials that either killed you or made you very sick. Thus early "toxicology" had no regard for long-term toxicity. Only immediate effects were considered.

Paracelsus (1493-1541), an early physician, was one of the first modern toxicologists who recognized that the quantity of the substance was a critical determinant of toxicity. His understanding of toxicology is defined by, "All substances are poisons, there is none that is not a poison. The right dose differentiates a poison and a remedy."

The first person known to recognize occupational illness was Percival Pott (1775), who observed high rates of scrotal cancer in London's chimney sweeps. The chemical culprit, found much later, was benzo-a-pyrene, belonging to a class called poly-nucleated aromatic hydrocarbons, which is a common product of combustion.

The last 30 to 50 years have exhibited explosive growth in the study of toxicology. Although this field may at first seem narrow, it is actually quite broad. There are many subdivisions, as displayed in the table below:

Type of Toxicology	Focus and Concern
Clinical	Concerned with the effects of chemical (drug) poisoning and the treatment of poisoned people.
Descriptive	Concerned directly with the toxicity-testing of chemicals.
Environmental	Concerned with the ultimate environmental fate of chemicals and their impacts upon the biological ecosystem and human populations.
Forensic	Concerned with applying techniques of analytical chemistry to answer mediological questions about harmful effects of chemicals.
Industrial	Concerned with the disorders produced in individuals who have been exposed to harmful materials during the course of their employment.
Mechanistic or Biochemical	Concerned with elucidating the biochemical mechanisms by which chemicals exert their toxic effects.
Regulatory	Concerned with assessing descriptive data with regard to the risk involved in the marketing of chemicals, their legal uses, and chemical reporting.

The HazMat Technician and Toxicology

The task of hazardous materials responders is to obtain and interpret this information in a manner that is useful at the hazardous materials incident. The next several sections attempt to familiarize HazMat Technicians with the major concepts and develop a basic understanding of toxicology.

What is Toxic?

It is not always clear what materials are toxic. For example, cyanide salts, commonly found in metal plating shops, are toxic. But, water and oxygen are toxic too. Most would agree that cyanide is very toxic, and the ingestion of small amounts can be fatal. Yet, we regularly ingest water, and we regularly inhale oxygen to survive. How can they be toxic?

A key concept of toxicology is quantity or dose. The quantity of material to which an organism is exposed directly determines its hazard. Water and oxygen in proper amounts are essential to sustain life. Yet, too much oxygen is toxic, resulting in biochemical disturbances and cellular damage. Too much water is also toxic and fatal!

This concept of dose and toxicity is very relevant to hazardous materials responders. The principle objective of any hazardous materials incident is to minimize and ultimately eliminate the quantity of hazardous material to which the responder, the general public, and/or the environment are exposed.

Toxicity + Risk = Chemical Hazards

Another key to accurate incident hazard evaluation is the proper comparison between the toxicity of a chemical and the potential risk it poses. Toxicity refers to the ability of a chemical to cause injury once it reaches a susceptible site in, or on, the body. Without considering risk and toxicity, an accurate hazard evaluation is unlikely. It must be understood that toxicity and the potential exposure risk defines the hazard in which the responder is exposed.

Risk is independent of toxicity, since it refers to the factors that determine the hazard of a material, not the intrinsic ability of a chemical to cause harm. The likelihood that a chemical will cause injury, susceptibility of the recipient, length of exposure, concentration and toxicity of the material are all factors which are significant to the hazard of a situation.

For example, cyanide salts are highly toxic, although they are not likely to cause widespread exposure problems because they are generally found in solid form and are not airborne and mobile. However, anhydrous ammonia, far less toxic than cyanide salts, may present a greater widespread risk because as a vapor, it is highly mobile.

Exposure may occur through a variety of different media. However, all the exposures may be grouped in terms of the time frame of exposure and time delay for the ultimate response.

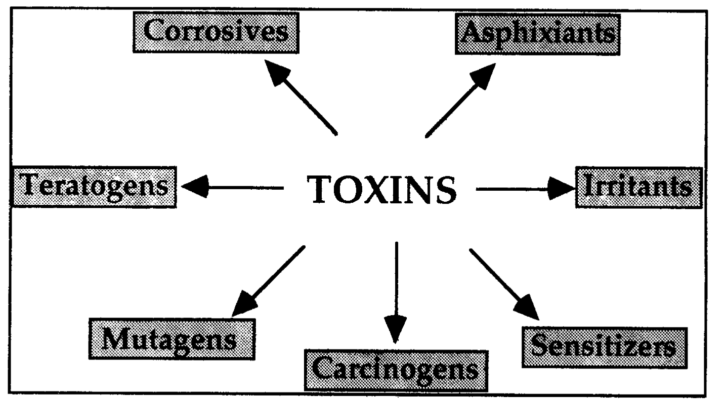
> **Acute -** single exposure or occurring over a short time period (1 day or less).
> **Subchronic -** intermediate exposures between acute and chronic, may be for up to ninety days.
> **Chronic -** multiple or constant exposure to concentrations that do not cause an acute toxic response.

Acute effects occur when one feels symptoms within a short period of time, (within minutes or hours). Examples of acute effects include: headaches, teary eyes, sore throat, dizziness and nausea. In contrast, a chronic effect or illness develops slowly and may last for a long time. Chronic poisoning is usually because of continued exposure to a harmful chemical for months or years. Examples of chronic effects include cancer, sterility, kidney and liver damage.

BE AWARE OF BOTH THE ACUTE AND CHRONIC EFFECTS OF A HAZARDOUS SUBSTANCE.

Hazardous Substance Exposure Health Effects

There are several types of toxic effects that hazardous substances may have on the body when exposure occurs. These are important to understand in an emergency situation. Some, such as acrolein (a common combustion byproduct) are so reactive that simple contact causes cytotoxicity (cellular death). Other toxins, though chemically inert, can fatally displace oxygen. Toxins are divided into several basic types: asphyxiants, corrosives, irritants, sensitizers, carcinogens, mutagens, and teratogens. Remember, however, that materials may fit in more than one category.



Asphyxiants: Asphyxiants are gases that deprive the body tissue of oxygen. There are two types: simple and chemical. $ *simple asphyxiant* displaces the oxygen in the breathing air. These are very important to identify in confined spaces and especially in emergency situations. Examples are carbon dioxide, ethane, helium, hydrogen, methane, argon, and nitrogen. Another type of asphyxiant is a *chemical asphyxiant.* Chemical asphyxiants are gases that actually prevent oxygen use by the cells even though enough oxygen is delivered. Examples are carbon monoxide, hydrogen cyanide, and hydrogen sulfide. At high levels, all asphyxiates can cause a person to collapse, become unconsciousness, and even die.

Simple asphyxiants are hazardous due to the hypoxia caused by oxygen depletion. Environments with oxygen levels less than 19.5% are considered hazardous and are illegal to enter without respiratory protection. A concentration of 7% (70,000 parts per million - ppm) of a simple asphyxiant is sufficient to cause hazardous oxygen depletion as displayed in the table below. A rule of thumb is that a given contaminant will deplete the oxygen concentration by one-fifth of the original contaminant concentration. A 10% (100,000 ppm) concentration of contaminant will deplete the oxygen by approximately 2%, which is very dangerous without supplied air.

Approximate Oxygen Levels Based on Contaminant Concentrations

Contaminant Gas (ppm)	Gas (% in air)	Oxygen Reading
10,000	1.0	20.7
20,000	2.0	20.5
30,000	3.0	20.3
40,000	4.0	20.1
50,000	5.0	19.9
60,000	6.0	19.7
70,000	7.0	19.5

Chemical asphyxiants act biochemically on the respiratory system. The toxicity of these compounds is not directly related to oxygen depletion. Consequently, much smaller concentrations of chemical asphyxiants are hazardous, as compared to simple asphyxiates.

There are several sub-groups of chemical asphyxiants based on where and how they affect the respiratory system. **Blood asphyxiants** combine with red blood cells and render them incapable of carrying oxygen to the cells in the body. Carbon monoxide, the most common blood asphyxiant, has a 200 times greater affinity for oxyhemoglobin than does oxygen.
Tissue asphyxiants are carried by the red blood cells and deposited in other cells of the body. They render the cell incapable of accepting further oxygen from the red blood cells. Hydrogen cyanide, a common material found in metal plating shops, and a common combustion by-product, functions by interfering with the cells ability to convert food sugars to a form more readily usable by the cell biochemical process. This eliminates the demand for oxygen, causing suffocation and cell death.

Similarly**, respiratory paralyzer asphyxiants** short circuit the respiratory central nervous system. Hydrogen sulfide (H_2S) attacks the olfactory nerve and paralyzes the nerve that controls the breathing process. Other examples of respiratory paralyzers are carbon disulfide (CS_2), acetylene, ethylene and ethanol.

Irritants: Irritants are toxins that cause temporary (but sometimes severe) inflammation of the eyes, skin or respiratory tract. Some examples of irritants are ammonia (NH_3), hydrogen fluoride (HF), chlorine (Cl_2), and hydrogen chloride (HCl). Irritants can also be corrosive materials which attack the mucous membrane surfaces of the body. These are more than "irritating." They are deadly at moderate concentrations. Irritants are divided into two types: respiratory and skin irritants.

Respiratory Irritants	May cause injury to the nose, mouth, throat and lungs. Examples of respiratory irritants that affect both the upper and lower lung are chlorine and ozone. Respiratory tract irritation can be minor, such as a tightening of the chest or bronchitis. But it may also be very serious, as in pulmonary edema, which can cause death.
Skin Irritants	May cause contact dermatitis, a redness, itching and drying of the skin. Examples are organic solvents and detergents. Very corrosive agents, such as chromium and nickel, can cause skin ulcers and destroy tissue.

The water-solubility of irritants will affect where they impact the body. Highly water soluble irritants, such as the halogen acid gases, (HF, HCl and Cl_2, HI, $S0_2$ and NH_3), will readily dissolve in the first moisture they meet; at the eyes, nose and throat. Moderately water soluble irritants are in the upper respiratory tract and lungs. Halogen gases, ozone, phosphorus trichloride and phosphorus pentachloride are examples of moderately water soluble irritants. Slightly water soluble irritants do not readily dissolve in water, and bypass the moist areas (mucous membranes) that the first two groups attack. These materials exert their damage deeper in the lungs by destroying the alveoli, sometimes with delayed effects of up to 12 hours. For example, nitrogen oxides can produce fatal effects, principally pulmonary edema, from 4 to 48 hours after exposure.

Allergenic Sensitizers: After repeated exposures to certain chemicals, some individuals experience an allergic or immune reaction. Allergic sensitizers generally affect the skin and respiratory tract. The symptoms are often the same as those caused by irritants. Symptoms include dermatitis or bronchitis. As with irritants, the response may be very serious, and may even cause death. Examples include: isocyanates, phenol resins, and epoxy resins.

Systemic Toxins (Internal Poisons): Systemic toxins are chemicals that can cause damage to vital organs in the human body. They can damage blood cells, the nervous system, the liver, the kidneys and reproductive cells. The following table provides a description of each type:

Blood System (Hemolytic) Toxins	These toxins damage blood cells or interfere with blood cell formation. Examples include benzene, methylene chloride, arsine, phosphorus, and naphthalene.
Nervous System (Neuro) Toxins	These toxins damage the nervous system. Typical symptoms include dullness, muscle tremor, restlessness, convulsions, loss of memory, epilepsy, and loss of muscle coordination. Examples include mercury, insecticides, hexachlorophene, and lead.
Liver (Hepato) Toxins	These toxins cause liver damage, including jaundice and liver enlargement. Examples include alcohols and carbon tetrachloride.
Kidney (Nephro) Toxins	These toxins damage the kidneys, causing swelling and increased serum proteins in the urine. Examples include halogenated hydrocarbons and heavy metals.
Reproductive Cell (Gameto) Toxins	These toxins damage the reproductive cells (egg and sperm) or interfere with their formation. Examples include lead, cadmium, cellosolves, and vinyl chloride.

Carcinogens:. Cancer is the uncontrolled growth of malignant (harmful) cells at any site in the body. Carcinogens are chemicals that are known to cause cancer in humans or animals. Over 200 substances are known human carcinogens. Many other substances are under study as suspected carcinogens. Carcinogens differ somewhat from other toxins for two important reasons: 1) very small amounts of material can cause a carcinogenic effect, and 2) the effects of exposure may not appear for years. Theoretically, one molecule can cause cancer (called the one-molecule one-hit theory), although cancer is much more likely after substantial, repeated, exposures. In general, it is believed that the development and problems caused by cancer may be delayed for 20 to 30 years after exposure. Whenever a known or suspected carcinogen is involved, responders must use the highest levels of appropriate protection. Some examples of carcinogens are coal, tar, asbestos, vinyl chloride, ethylene dibromide, toluene and benzene.

Teratogens: Terata" in Greek means “monster.” Teratogens are agents that are known for their ability to cause malformations in an unborn child. Classic forms of fetal malformations are phocomelia (reduced limbs) or amelia (absent limbs). Chemicals are classified as teratogens and reproductive toxins if they affect the ability to conceive, bear, or nurture offspring, and anything that influences the function or viability of sperm cells. Teratogens are toxins that cause physical defects in a developing embryo or fetus. Some substances known to be teratogenic in humans are anesthetic gases, organic mercury compounds, and ionizing radiation.

Mutagens: Mutagens are toxins that cause a change (mutation) in human genetic material (DNA and RNA). Mutation of the reproductive cells may cause birth defects in future children. These genetic changes can have numerous effects including the failure of important biochemical processes. Some known human mutagenic toxins are: ethylene oxide, ionizing radiation, hydrogen peroxide, hydrazine, EDB (ethylene dibromide) and benzene. Mutation of other cells in the body may cause cancer or defects in developing embryos or fetuses.

Corrosive Hazards: Corrosives are also defined as those materials causing irreversible damage to living tissue upon skin contact, as determined in laboratory studies. Corrosive materials are capable of destroying metals as well as organic materials (such as skin tissue). Some corrosive materials may also be strong oxidizers such as nitric and perchloric acids. Examples of high pH corrosive materials are sodium hydroxide and potassium hydroxide. Inorganic chlorides such as phosphorus pentachloride, stannic tetrachloride, and thionyl chloride are also corrosives, because they yield hydrochloric acid upon hydrolysis.

Biological Hazards: Wastes from hospitals, medical offices, and research laboratories may contain infectious substances that can cause infection or disease in humans. These substances are called etiologic agents or regulated medical waste and may be contained in water and dispersed by the wind. These substances may be in the form of body parts, sharps (needles), bandages and vials containing human blood. Other biologic hazards may be contained in poisonous plants, insects, animals and indigenous pathogens. Hazardous waste site workers must be aware of these types of substances and be capable of identifying them.

Radioactive Hazards: Radiation hazards, although very dangerous, are the least likely to be encountered. There is a much higher probability of exposure to chemical and physical hazards at a hazardous material site or during an emergency response operation at the shipyard. Surprisingly enough, radiation hazards are easily detected, measured and controlled. There are two types of radiation: non-ionizing and ionizing. Non-ionizing radiation is present in daily life from microwave ovens, and radio and television waves.

Reactivity: Reactive materials may cause fires, explosions and may liberate toxic gases during their reaction that are hazardous to human health and the environment. Reactives are dangerous for the HazMat responder because they can be unpredictable. In general, reactive substances exhibit one or more of the following characteristics:

- Normally unstable and readily change violently without detonating.
- Reacts violently with water.
- Forms potentially explosive mixtures with water.
- When mixed with water, generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.
- Cyanide or sulfide bearing waste that, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.
- Capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.
- Readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.

These characteristics generally define highly reactive materials such as explosives, water reactive materials (i.e., sodium, strong acids) or sulfide and cyanide bearing compounds.

Some compounds by themselves are not reactive when mixed with other materials having similar properties and do not produce dangerous reactions. However, the same compounds, when mixed with materials that are not compatible, will cause an adverse reaction. For example, two mineral acids such as sulfuric and hydrochloric, when mixed do not adversely react. However, mixing one of the same compounds with methyl ethyl ketone will cause the generation of heat and fire.

When examining possible mixtures of compounds, it is necessary to evaluate the compatibility of the compounds. An incompatible mixture of compounds could produce one or more of the following: heat, polymerization, fire, explosions and gas (toxic and/or flammable). For example, spilling an oxidizing material onto clothing or mixing it with a material such as sawdust will cause heat and fire.

Some compounds are reactive with water. Calcium carbide, a granular type of material is a flammable solid and dangerous with a wet substance. If a container is left open on a humid day, moisture from the air will be absorbed and initiate a fire. This reaction will also generate flammable acetylene gas.

Toxicity and Routes of Exposure

The dose makes the poison. This is the basic tenet of toxicology. Since the dose is the amount of substance to which an organism is exposed, a restatement could be **the exposure makes the poison**. Exposure is dependent upon the degree to which a substance, in absorbable form, comes in contact with surfaces of an organism capable of absorbing it.

The concept of exposure routes is very important for the shipyard HazMat Technician Responders because of their need to recognize a hazardous situation where exposure can be extremely dangerous or even fatal. There are three main routes by which toxins can enter the body: absorption, inhalation and ingestion.

Exposure Route	Absorption Site
1. Inhalation	**Lungs** by inhalation (breathing in) and absorption through the lung walls into the body
2. Dermal	**Skin** by direct contact and absorption through the skin into the body (also eyes)
3. Oral	**Digestive tract** by ingesting (swallowing) substances into the body's digestive tract or gastrointestinal (GI) tract

Note: The route of exposure can result in different rates of absorption and different toxic effects. Exposures can be controlled by using proper personal protective equipment (PPE).

Inhalation Exposure (The Lung Exposure Route)

Inhalation exposure is the most common way that hazardous substances enter the body, especially in an emergency response situation. The lungs are the largest exposed surface area of the body and facilitate the transfer of gases into and out of the body. If your alveoli (the tiny sacs at the bottom of the lungs) were flattened out, they would cover an area the size of a tennis court. This huge surface area is only a single cell thick, which allows a chemical to travel into the bloodstream quickly. The large surface area can result in rapid absorption into the bloodstream.

The most significant factor in the rate of absorption for inhalation is respiration. The rate of absorption can increase substantially if the rate or depth of respiration increases. This has important implications for hazardous materials responders who are likely to be performing heavy physical work in contaminated environments, and therefore, are breathing faster and deeper.

Since the lungs serve as an absorption point, they can also be the route of entry into the body for many substances that effect target organs, or systems other than the lungs themselves. An important example of a systemic toxin absorbed through the lungs is carbon monoxide.

The mucous cells within the lining of the nose trap inhaled dirt and other foreign particles, pushing them toward the throat where they are swallowed. Most inhaled foreign particles are delivered to the digestive system in this way. Although the digestive system is less delicate than the lungs, and more capable of disposing of hazardous materials, it still may be severely effected by substances that enter the body through inhalation.

Similarly, potentially hazardous particulate compounds may be deposited in different areas of the lungs depending on the particle size, with the smallest particles penetrating the furthest. Once deposited, particulates in the lungs can have acute or chronic toxic effects.

Factors that may influence the absorption of inhaled toxicants are:

- Specific gravity of the particle
- Particle charge
- Hygroscopicity
- Respiratory frequency
- Respiratory depth
- Local temperature and humidity
- Nature of the aerosol (fineness of dispersion)

Toxic Effects of Inhalation

The responses of the respiratory system to toxic agents may be divided into the following general categories:

- **Irritation of the respiratory tract** results in constriction of airways and may lead to infection and fluid build-up in the lungs. Examples of chemicals that cause irritation are hydrogen chloride and ammonia.
- **Sensitization** can lead to short-term constriction of the airways through an allergic response and may also develop into long-term or chronic pulmonary disease. Examples include isocyanates and sulfur dioxide.
- **Production of fibrosis (scar-like tissue)** may block the air passages, thereby causing decreased lung capacity. Examples include silica, asbestos and beryllium.
- **Development of lung cancer, and resulting necrosis (cell death).** Examples include coke oven emissions, asbestos and arsenic. The lungs are also the entry site for asphyxiants and other toxins.

Dermal Exposure (The Skin Exposure Route):

The skin is a specialized organ that provides a barrier between the environment and internal organs. The skin is not highly permeable and provides good protection against most compounds. Although a small amount of toxicants can enter through the hair follicles and sweat glands, the majority of chemicals must pass through the densely packed skin cells before entering into the blood stream. Hazardous materials responders should never assume that the skin provides adequate protection in a situation involving hazardous materials. If the skin is damaged, its protective barrier can break down immediately.

It is important to remember that many forms of chemicals, including solids, liquids, gases and vapors, can affect, and penetrate, the skin. The amount of toxin absorbed depends on skin condition factors, chemical quantity, concentration, total time contact is maintained, surface area and location of skin exposed to the hazardous substance.

Factor	Description
Skin Condition	Skin condition factors can increase susceptibility to further damage from toxins, as well as increase absorption into the body. This includes skin that has been previously damaged by trauma, heat, cold, humidity, or chemical exposure.
Quantity of Dosage	Absorption of materials through the skin is time-dependent, which means the longer the contact, the more that will be absorbed. Usually, the longer the duration of exposure, the more severe the toxic response. Chlordane, malathion, and DDT are examples of chemicals that can cause cancer if the cumulative exposure is sufficient.
Local Factors	Local factors such as temperature and blood flow at the entry site will also influence the rate of absorption. High temperature conditions, such as found in chemical protective clothing, can actually increase the skin absorption rates of some chemicals.
Exposure Site	The site of skin in contact with the toxin is important since permeability differs according

	to body region. Areas rich in hair follicles, such as the scalp, forehead, jaw area and underarm, allow much greater absorption than do other parts of the body. The skin of the scrotum allows almost total absorption of some chemicals.
Enhanced Absorption	Absorption can be enhanced if the substance and skin are covered, for example by a bandage or clothing. Moisture due to sweat will also increase absorption.

Other factors that may influence the absorption of substances through the skin are:

- Contact between clothing and skin
- Increased temperature of the skin
- Use of solvents that facilitate penetration
- Increasing toxicant concentration
- Humidity of the skin
- Damage to the skin (cuts, abrasions)
- Altering pH of the skin
- Decreasing toxicant particle size

Two Toxic Exposure Examples:

1) The same amount of mustard you would put on a hot dog, if placed on the skin (dermal exposure), would be a local irritant.
2) Cutting an onion results in eye irritation yet no irritation to the hands.

Toxic Effects of Skin Absorption

Contact with a chemical substance by the skin may cause two major effects: 1) The Local Effects and 2) The Systemic Effects

1) The Local Effects:	
Irritation	Many chemicals cause an immediate reddening, rash, or other irritation to the skin upon contact.
Tissue damage	Chemicals such as corrosives, including acids or bases, eat into the skin and cause damage to the tissue beneath it.
Allergic effects	Some chemicals, such as nickel, chromium, formaldehyde, turpentine, and isocyanates, cause the skin to become hypersensitive after repeated exposures. This is called sensitization dermatitis.
2) The Systemic (internal) Effects:	Systemic effects from absorption through the skin. Many solvents are absorbed through the skin, circulated through the bloodstream, and then cause damage within the body.

Oral Exposure (The Digestive Tract Exposure Route)

The oral route is the third way a chemical can enter the body. The main point of entry of this type of exposure is through the mouth. The chemical then passes to the gastrointestinal (GI) tract, which can be thought of as a “tube” going through the body. Chemicals that are eaten, intentionally or accidentally, may be absorbed into the body through this “tube”. Ingestion is the most common route of entry in cases of suicide and childhood poisoning, but less likely in work and environmental exposures. However, ingestion can occur when substances or contaminated hands, or clothing, come in direct contact with the mouth. In addition, some toxins may be consumed by eating meals or smoking in an environment where food and cigarettes can become contaminated. Metals such as lead, cadmium and arsenic are absorbed following their ingestion.

The cells that line your upper respiratory tract (bronchia, throat) have small hair-like projections called cilia. These cilia move back and forth to carry mucous from the lungs to the throat, where they may be swallowed or spit out. Dusts that were filtered out in your upper respiratory tract can be trapped in the mucus and moved to your mouth where you can swallow them. In workplaces where dust levels are very high, ingestion (swallowing), has been a primary route of exposure. For example, lead exposure in radiator shops has caused several cases of stomach cancer.

Absorption rates for the different regions of the GI tract will vary due to difference in pH and surface area. Therefore, the region of greatest absorption will be different for different compounds. In the workplace, many people may eat or drink harmful chemicals without knowing it. Toxic (poisonous) materials are absorbed from the digestive tract into the blood stream.

Personal hygiene is essential in the workplace. This requires responders to always:

- Wash thoroughly before eating, drinking or smoking
- Eat, drink and smoke in clean areas only

Toxic Effects of Ingestion: When a toxin is ingested, it affects the entire gastrointestinal system, which includes the mouth, pharynx, esophagus, stomach, small intestine and large intestine, as well as several other organs within the gastrointestinal system. These organs are collectively responsible for the absorption, digestion and storage of nutrients for human life. Like all organs, the gastrointestinal system may also be effected by toxins that enter the body through the skin or lungs. Some of these toxins may cause liver toxicity resulting in inflammation or other diseases such as:

Cirrhosis: Cirrhosis is a progressive disease of the liver, which may occur with chronic exposure to carbon tetrachloride, but the most common cause is chronic alcohol consumption.

Malignant tumors: Vinyl chloride monomer (used in making the polymer of vinyl chloride) can cause malignant tumors of the liver. Other suspected liver carcinogens are DDT, dieldrin and trichloroethylene.

Dose/Response Relationship

The dose/response relationship is the basis for measuring of toxicity. This relationship rests upon three assumptions:

1. The response is a function of the concentration at a site.
2. The concentration at a site is a function of the dose.
3. The response and dose are causally related.

These assumptions are simply stating that for the dose/response to be valid, increasing the dose should increase the concentration at the site of toxicity. All toxicology studies are based on the dose-response relationship. This is an attempt to relate the amount of a substance (the dose) given to a test animal to the effect shown by the animal (the response). The following table displays the dose/response relationship:

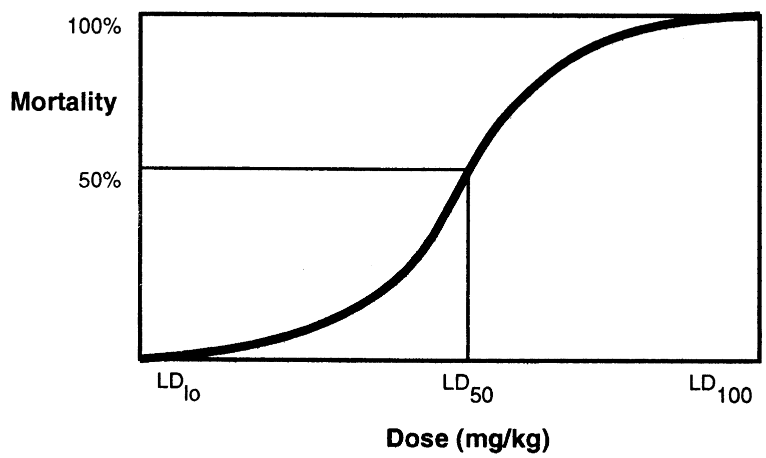
Example of the Dose/Response Concept:

Dose = Concentration	Time	Response
1 quart of 12% ethanol (alcoholic beverage)	15 mins.	brain effects ("drunk")
1 quart of 12% ethanol	daily	chronic organ damage
1 quart of 12% ethanol	annually	no observed effect

Note: The same dose given over a short period of time may have a substantial effect, while the same dose over a long period of time may have no effect at all.

Typical Dose-Response Curve

The mean response of a group at a particular dose is called the dose-response relationship. A way of representing the response of a population to different doses is with the siginoid dose response curve. This curve compares the percentage of mortality among test subjects across a range of doses.



A basic piece of information available from the curve is the toxicity of the material. The curve shows that the effect of increasing the dose, results in increased mortality of test subjects. Some individuals died at relatively low concentrations, while the hardiest succumbed only at the highest dosage. The most toxic materials have the steepest curves, meaning that the difference in dosage between when the first death is observed, and where the entire population expired, is small.

Toxic Chemical Responses

The range of observable undesired effects resulting from exposure to a hazardous substance is broad. Some compounds may have numerous toxic responses. The identification of compounds by the type of response they cause can be quite useful. For example, compounds that cause delayed toxic effects may require more caution because they may give limited signs of exposure. Some chemical classifications are presented on the following page:

Immediate And Delayed Responses	
Immediate	Single administration, rapid onset (ethanol, nerve gases, aspirin)
Delayed	Occur after a lapse of time (carcinogens - latency period 20 - 30 years)
Reversible and Irreversible	
Reversible	Re-establishment of normal function or regeneration of injured tissue (anti-cholinesterase, most liver toxicity because of the liver's ability to regenerate)
Irreversible	Permanent functional or tissue injury (teratogens, most CNS toxicity since differentiated cells cannot divide and be generated)
Acute and Chronic Responses	
Acute	Response following a single or short term exposure (acid, mace)
Chronic	Response following repeated small dose carcinogens (DDT, lead)
Local and Systemic Injuries	
Local	Injury at the site of first contact (caustic substances, inhalation of irritants)
Systemic	- Injury following absorption and distribution - Most systemic effects have one or two target organs Most frequent target: CNS, Next: circulatory system Least frequent: muscle and bone (lead - accumulated in bone - toxic in soft tissue DDT - concentrated in adipose tissue - no toxic effect there)

Synergistic and Antagonistic Effects	
Additive	The effect of two toxicants is equal to the sum of their individual effects (2 anticholinesterase, - malathion and carbaryl)
Synergistic	The combined toxicity is greater than the sum of the individual effects (carbon tetrachloride and ethanol; asbestos and smoking)
Antagonistic	Combined toxicity is less than the sum of the individual effects (atropine and nerve gas)

Toxins and their Effects

When a set of test animals is exposed to a given dose of a toxin, some may show minimal effect while others are more affected by the same dose. Any measure of the toxicity of a material must account for the mean, or average, response of a population, rather than the particular response of an individual. Individual variabilities includes sex, age, individual susceptibility, nutrition, and health, which are explained in the table below:

Sex:	Males and females exhibit different responses. For example, females typically have higher body fat, and thus may be more susceptible to fat soluble substances. Males, on the other hand, may experience reproductive harm if the toxin targets rapidly growing cells. Females are susceptible to teratogenic and mutagenic threats if pregnant, with the first trimester, the most vulnerable.
Age:	Metabolism of foreign compounds is an important detoxifying (and toxifying) process. Biochemical processes in the liver, for example, include the conjugation of glutathiorie (a protein) with the toxic compound to render it inactive and non-toxic. Older individuals tend to have lower glutathione levels and are less able to deactivate toxins. The greater the age of the individual, the more vulnerable they are to toxins. Respiratory and cardiac disease are more common in older individuals.
Individual Susceptibilities	Allergies or other physical impairments can increase one's sensitivity to particular chemicals. Occasionally someone may report reactions to household chemicals, for example, that otherwise wouldn't affect the general population. Obviously the same may be true with industrial chemicals.
Nutrition & Health:	Physically fit persons are less susceptible to chemical exposures. The natural mechanisms that the body has for dealing with chemical exposures are at their peak when one is in good health. On the contrary, illness or poor health can mask symptoms from a chemical exposure. For example, a persistent cough may be attributed to a cold or flu, instead of a chlorine gas exposure.

Measurement of Exposure

The terms and definitions for measuring toxicity are an essential part of a hazardous materials responder's vocabulary. This data represents the relative hazard of toxicants, allowing responders to make assessments about the threat of an incident. Generally, the lower the numbers, the more toxic the material.

When people think of a dose, they usually think of one vitamin a day, or two aspirins every four hours. This type of dosage would result in different exposures depending upon the size of the recipient. The use of laboratory animals in toxicity tests would result in even greater size disparities.

To provide a uniform measure of exposure, the dosage is usually expressed as a ratio of the weight of the chemical to the weight of the animal. In this way, it is possible to extrapolate the test animal dosage to humans.

Measures of Exposure (Dose)

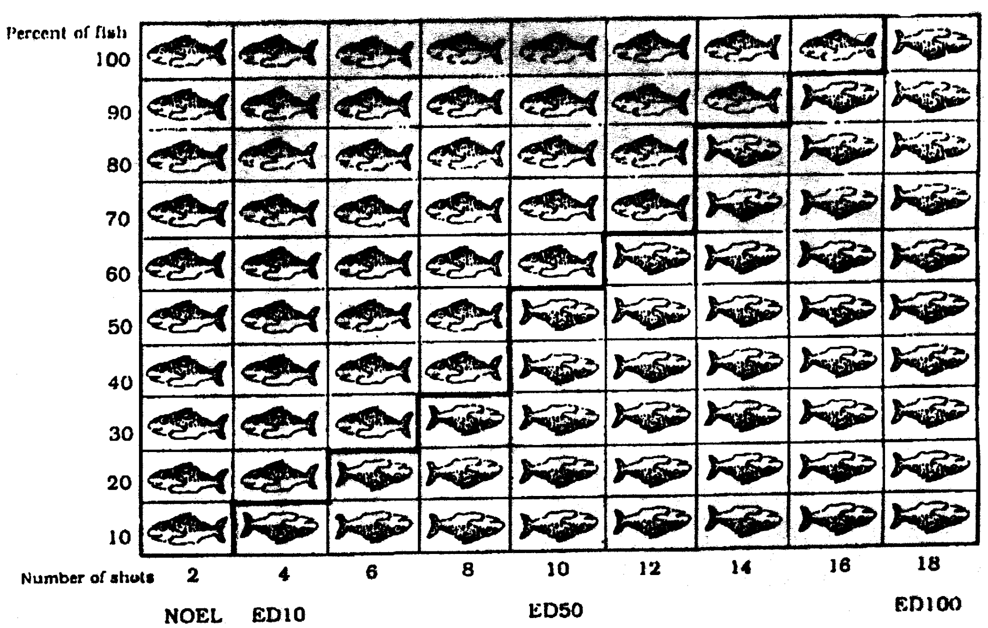
Dose	Abbreviation	Metric Equivalent	Abbreviation
parts per million	ppm	milligrams per kilogram	mg/kg
parts per billion	ppb	micrograms per kilogram	ug/kg

Lethal Dosage (LD-50) and Lethal Concentration (LC-50)

The simplest toxicology study relates the percentage of test animals that die (mortality response) from the dose given. The dose is usually expressed in mg/kg (for ingestion or inoculation), in mg/M^2 (for skin exposure), or in mg/M^3 (for inhalation). The response is expressed in percent (%) of animals that have died. The dose of a chemical that kills 50% of the test animals is the LD-50.

LC-50 is usually expressed in parts per million in air. It is the concentration that kills half the population in a given observation period. It is independent of body weight. The LC-50 measurement is used to determine the toxicity of vapors, fumes and dusts in air. The test procedure is very similar to LD-50 tests. The lethal dosage and concentration measures acute toxicity and is commonly used to measure relative toxicity. The important thing to remember is that a low LD-50 value indicates a more toxic chemical, (i.e., 1 mg/M^3) while a high LD-50 (i.e., 10,000 mg/M^3) indicates a less toxic chemical.

An example of the dose/response relationship is illustrated by dumping shots of I00-proof whiskey into a ten-gallon tank containing ten goldfish. How many shots (dosage) will cause the fish to swim upside down? After one or two shots, none of the fish die, but after about four shots, one of the fish dies. As more shots of whiskey are added, more fish begin to die. After ten shots, five of the ten or 50% of the goldfish are swimming upside down. If the effect being observed is death, then the lethal dosage (LD-50) would be the measure of the lethal dose for 50% of the population.



High LD values describe chemicals that are less toxic. The following table displays some of the LD-50 values for several substances. Notice that Dioxin (TCDD) and Botulinus toxins are extremely deadly.

Approximate Acute LD-50 s of a Selected Variety of Chemical Agents

AGENT	LD-50 (mg/kg)
Ethyl alcohol	10,000
Sodium chloride	4,000
Ferrous sulfate	1,500
Morphine sulfate	900
Phenobarbital sodium	150
DDT	100
Picrotoxin	5
Strychnine sulfate	2
Nicotine	1
d-Tubocurarine	0.5
Hemicholinium-3	0.2
Tetrodotoxin	0.10
Dioxin (TCDD)	0.001
Botulinus toxin	0.00001

Probable Oral Lethal Dose for Humans: Hazardous substances can be ranked by their potential human toxicity. The table below describes the five different levels that are generally used to rate level of toxicity. It relates the lethal dosage for an average adult and the respective lethal ingested quantity:

Toxicity Rating or Class	Lethal Dose Concentration For Average Adult	Lethal Quantity For Average Adult
1. Practically non-toxic	> 15,000 mg/kg	More than 1 quart
2. Slightly toxic	5,000 -15,000 mg/kg	Between pint and quart
3. Moderately toxic	500 - 5,000 mg/kg	Between ounce and pint
4. Very toxic	50-500 mg/kg	Between teaspoon and ounce
5. Extremely toxic	5-50 mg/kg	Between 7 drops and teaspoon
6. Supertoxic	< 5 mg/kg	A taste (less than 7 drops)

OSHA establishes enforceable safety standards or criteria for chemicals that are designed to protect public health. The basis for the standard is usually a toxic response occurring at a much lower dose than where mortality occurs. Therefore, tests are devised to determine the dose which produces no observable adverse effects when small doses are administered over a period of time. Many standards and criteria have been established. However, they are all based on determining the dose level where toxic responses will not occur, and then dividing this dose by a safety factor to compensate for uncertainty.

No Observed Effect Level (NOEL): The highest concentration or dosage where no effect is observed.

Threshold Limit Value - Time Weighted Average (TLV-TWA): This is the upper limit of a toxic material to which an average person, in average health, may be exposed on a day to day basis (40 hour work week, 8 hour work periods), with no adverse effects. TLVs are typically expressed in milligrams per cubic meter (mg/m3) for gases or vapors and micrograms per cubic meter (ug/m3) for

fumes and mists. These are time weighted averages and are not intended as a definitive line between safe and dangerous concentrations, but rather allow excursions above the TLV only when the average exposure does not exceed the TLV-TWA.

Threshold Limit Value - Ceiling (TLV-C): This is the maximum limit of a toxic material to which an average person in average health may be exposed on a day to day basis (40 hour work week, 8 hour work- periods) with no adverse effects. This value is used in conjunction with TLV-TWA and represents the maximum limit of excursions above the TLV-TWA. TLV-C is considered allowable, provided the average exposure throughout the work week does not exceed the TLV-TWA.

Permissible Exposure Limit (PEL): This is the maximum permitted 8-hour time weighted average concentration of an airborne contaminant. The PEL is determined by OSHA and is equivalent in definition to the TLV-TWA which is set by the American Conference of Governmental Industrial Hygienists (ACGIH). The PEL is a legal limit whereas the TLV is a recommended standard. Often they are the same values.

Short Term Exposure Limit (STEL): This is the maximum permitted exposure for no more than 15 minutes.

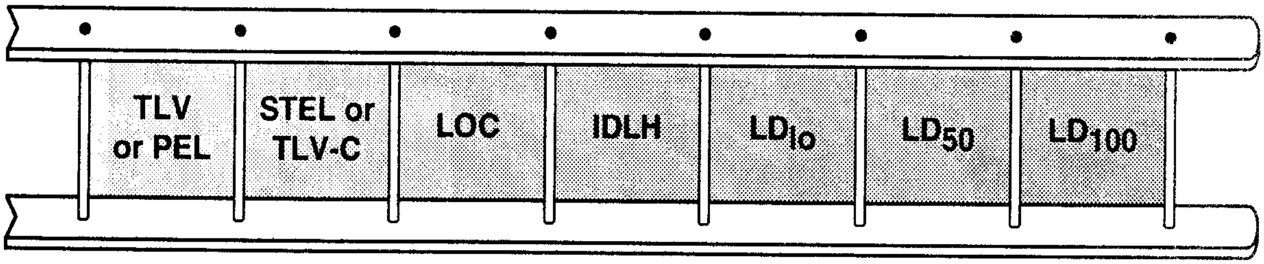
Immediately Dangerous to Life and Health (IDLH):
This is the concentration of airborne contaminants, normally expressed in parts per million (ppm) or milligrams per cubic meter, which represents the maximum level from which one could escape within 30 minutes, without any escape-impairing symptoms, or irreversible health effects. This level is established by both the National Institute of Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH). The ACGIH definition differs from NIOSH in that irreversible health effects are not considered. Therefore, carcinogenic compounds are not included in ACGIH IDLH listings.

Maximum Allowable Concentration (MAC): Absolute maximum exposure (ppm) at a given time.

Level of Concern (LOC): This value is used to determine the geographic area of risk in the event of a chemical release. LOC is generally defined as IDLH/10. Typically, evacuation or protection measures may be necessary in LOC conditions.

Limit	Exposure Duration	Legally Mandated?	Comments
TLV	8 hours per day up to 40 hours per week	No	Set by ACGIH
PEL	8 hours per day up to 40 hours per week	Yes	Set by OSHA
STEL	15 minutes	Yes	Set by OSHA
IDLH	30 minutes for escape only	No	Determined by NIOSH
LOC	None	No	Evacuation Guideline

One way to visualize the relative ranking of the various toxicity terms for a material is the hazard ladder. Each toxicology value is arranged in order of increasing concentration and severity. TLVs for example, are the lowest numbers and they represent levels which cause relatively minor effects. Conversely, LD-100 values are comparatively large and fatal.



Emergency Response Planning Guide (ERPG)
Hazardous concentrations have been developed for emergency response situations where response individuals may be exposed for short periods of time. These ceiling limit values are developed and recommended by the American Industrial Hygiene Association (AIHA). The ERPG limits are not intended for repeated or extended exposures. The three levels are defined as follows:

ERPG-1: Maximum airborne concentration to which nearly all individuals could be exposed for up to one hour, without experiencing or developing health effects more severe than sensory perception, or mild irritation.

ERPG-2: Maximum airborne concentration below which, it is believed, nearly all individuals could be exposed for up to one hour, without experiencing or developing irreversible, adverse or other serious health effects or symptoms, which could impair an individual's ability to take protective action.

ERPG-3: Maximum airborne concentration below which, it is believed, nearly all individuals could be exposed for up to one hour without experiencing or developing life threatening health effects.

The MSDS: A Valuable Tool For Determining a Substance Toxicity

The Material Safety Data Sheet (MSDS) is the primary source of technical information concerning safe handling procedures and health affects of a chemical. According to OSHA Hazard Communication Standard (HCS) regulations, an MSDS must be readily available near the work station for every hazardous chemical used. Employees must know how to obtain an MSDS, and must be trained on how to interpret them. Since the central role of the MSDS is to provide hazardous material safety information, it is important that the Operational Level Responder understands how to read them effectively.

This training session provides a section by section review of the MSDS and the kind of information that must be provided by companies furnishing MSDSs. Although, the format of many MSDSs may be somewhat different, each MSDS must contain all these elements. The following table provides an outline of a typical MSDS and the subjects contained in each section:

MSDS SECTION	OUTLINED INFORMATION
SECTION I **MANUFACTURER / PRODUCT IDENTIFICATION**	Product name Address of manufacturer's importer or other party responsible for preparing the MSDS. Emergency and non-emergency telephone numbers The date prepared or last changed
SECTION II **HAZARDOUS INGREDIENTS/ IDENTITY INFORMATION**	Hazardous chemical names Chemical identity CAS #, and concentration (%) OSHA PEL limits in air ACGIH TLV limits in air
SECTION III **PHYSICAL/CHEMICAL PROPERTIES**	Vapor density Melting point or range Specific gravity Boiling point or range Solubility in water Appearance and odor Warning properties
SECTION IV **FIRE AND EXPLOSION HAZARD DATA**	Flash point Auto-ignition temperature Lower explosive limit (LEL) Upper explosive limit (UEL) Special fire fighting procedures Fire extinguishing materials Unusual fire and explosion hazards
SECTION V **HEALTH HAZARD INFORMATION**	Symptoms of overexposure for each route of exposure How to recognize exposure Acute and chronic effects of exposure First Aid Emergency Procedures for exposure Suspected carcinogens (yes or no) Medical conditions aggravated by exposure
SECTION VI **REACTIVITY DATA**	Product stability Conditions to avoid Materials to avoid Hazardous decomposition Hazardous polymerization
SECTION VII **SPILL LEAK & DISPOSAL INFORMATION**	Spill response procedures Proper disposal of spilled wastes

SECTION VIII **PRECAUTIONS FOR SAFE HANDLING AND USE**	Ventilation and engineering controls Respiratory protection Eye protection Clothing and equipment Hand protection (gloves) Good work practices, handling, and storage requirements Decontamination of equipment
SECTION XI **LABELING**	DOT shipping name Precautionary statements NFPA hazard rating

The following describes the MSDS sections, outline information presented, identify key terms, and provide for a better MSDS understanding.

SECTION I - MANUFACTURER S IDENTIFICATION

The first section of the MSDS contains the name and address of the chemical manufacturer, importer or party responsible for preparing the MSDS. Both emergency and non-emergency telephone numbers are provided for obtaining additional information on the hazardous product. The date that the MSDS was prepared or last changed should also be included in this section.

The most important information contained in this section is the emergency information phone numbers. This gives the caller access to an individual that should be educated about the product and associated health risks, clean-up procedures, and personal decontamination. The person at the emergency phone should be able to clarify the information provided on the MSDS over the phone.

SECTION II - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

Any chemical substance that has been found to present a physical or health risk must be identified on the MSDS by its specific chemical name and its common name. Chemical mixtures that have been tested as a whole, and have been determined to be hazardous, must be listed by the chemical and common names of the components that contribute to the hazard(s), as well as the common name(s) of the mixture. Mixture ingredients which have been identified as carcinogens or potential carcinogens by the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC) or OSHA, and comprise 0.1 percent, or greater, of the total mixture composition, must also be listed and identified by both the chemical and common names. The table below provides a description of the key terms that will be encountered in this section of the MSDS.

Key Terms	Description
ACGIH	American Conference of Governmental Industrial Hygienists is a private organization of occupational safety and health professionals. ACGIH limits are usually lower (more stringent) than OSHA limits, but are not legally enforceable.
OSHA	Occupational Safety and Health Administration is the federal agency which sets safety and health standards and regulates working conditions in most of the nation's workplaces.
CAS#	The Chemical Abstracts Service Registry Number is a number given to each chemical that identifies it as a specific chemical compound.
PEL	Permissible Exposure Limit is the amount of a chemical to which a worker can legally be exposed. It can be an average exposure over time, or a one-time maximum exposure limit. This limit is established by OSHA.

TLV	Threshold Limit Value is an exposure limit recommended by ACGIH. There are three types of ACGIH TLVs : **TLV-TWA -**The allowable Time-Weighted Average concentration for an eight-hour work day. **TLV-STEL -**The Short-Term Exposure Limit, or maximum average concentration, for a continuous 15 minute exposure period. **TLV-C -**The Ceiling Limit, or maximum concentration, that should not be exceeded even for a split second.
Ppm	Parts per million, or parts of the chemical per million parts of air.
mg/m^3	Milligrams per cubic meter. This is the weight of the chemical (usually a dust or vapor) in a particular volume of air.

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

This section of the MSDS requires the inclusion of several important physical/chemical characteristics of the hazardous substance. Among these are the boiling point, melting point, specific gravity, vapor pressure, evaporation rate, vapor density and solubility. The physical appearance and odor of the compound are also required information. This is very important for both hazard recognition and emergency response analysis. The table below provides a description of the key terms encountered in this section of the MSDS.

Key Terms	Description
Boiling Point	The boiling point of a chemical or chemical mixture is the temperature at which the vapor pressure of a liquid equals the atmospheric pressure. Therefore, it is the temperature at which the substance rapidly changes from a liquid to a gas. The lower the boiling point, the more quickly it will evaporate and emit potentially harmful vapors into the air.
Melting Point	The melting point is the temperature at which a solid will be in equilibrium with the liquid phase at atmospheric pressure. At this temperature, a solid will begin to flow like a liquid.
Evaporation Rate	The time required to evaporate a certain volume of a liquid chemical compared to the time required to evaporate the same volume of a reference liquid (usually ethyl ether). In general, the higher the evaporation rate, the lower the boiling point, and the greater potential for release of hazardous vapors.
Solubility	The solubility of a substance in water should be reported as the percentage of product (by weight) that can be dissolved in distilled water at a specified temperature.
Specific Gravity	Specific gravity is the ratio of the density of a liquid, or solid, to the density of an equal volume of water at a specified temperature. A substance with a specific gravity <1.0 will float on water, while substances with specific gravity >1.0 will sink in water.
mmHg	Millimeters (mm) of the metal mercury (Hg) is a unit of measurement for pressure. For example, when used to define vapor pressure, it shows how likely a liquid is to vaporize. At sea level, the earth's atmosphere exerts 760 mm Hg of pressure.
Vapor Density	Vapor density is expressed as the density of chemical vapor relative to that of air, which is assigned a vapor density of 1.0. Knowledge of the vapor density of a chemical product will allow the Operational Responder to determine whether the vapor will rise or sink in the ambient air. A chemical with a vapor density less than 1.0 will rise in air, while a chemical with a vapor density greater than 1.0 will tend to sink in air and "flow" along the ground, collecting in puddles.
Vapor Pressure	Vapor pressure refers to the pressure (expressed in mmHg) exerted by a chemical vapor in equilibrium with its liquid or solid phase at any given temperature. Information on vapor pressure can provide the Operational Responder with an indication of how easily a chemical can become airborne. The higher the vapor pressure, the more likely it is that significant quantities of a chemical will be airborne, if it escapes. High vapor pressure is greater than 10 mmHg. Low vapor pressure is less than 1 mm Hg.
Appearance and Odor	The appearance and odor of a chemical product is identified by using the appropriate descriptive terminology. For example: viscous, colorless liquid with an aromatic odor.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

The MSDS should detail any unusual fire or explosion hazards that are inherent to the hazardous substance or dangers that may be initiated by a change in environmental conditions. The information that is required for chemicals is the flash-point, flammable limits, lower exposure limit (LEL), upper exposure limit (UEL), recommended extinguishing media, special fire fighting procedures, and unusual fire and explosion hazards. Some chemicals, for example, known as pyrophorics, can ignite spontaneously when they come in contact with air. No flame or spark is needed, which must be identified on this section of the MSDS. The table below provides a description of the key terms that will be encountered in this section of the MSDS.

Key Terms	Description
Combustible	Able to catch fire and burn. Moderate fire risk chemicals with a flash-point between 0°F. and 200°F. are considered combustible.
Flash-Point	The lowest temperature at which a liquid gives off enough flammable vapor to ignite (start to burn) if it comes in contact with a spark, flame or other ignition source. If the flash-point is less than 100°F, a cigarette or static electricity could start a fire. A chemical whose flash-point is less than the temperature of the area where it is used or stored, poses a problem.
Ignition Temperature	Ignition temperature is the minimum temperature required to initiate self-sustained combustion of a material. This temperature may be the same as the flash point but is usually slightly higher.
Auto-ignition Temperature	The auto-ignition temperature is the lowest temperature in which a material will spontaneously ignite and burn. In this situation, heat is the only source of ignition. For most materials, the auto-ignition temperature tends to be high (several hundred degrees Celsius). However, some material, such as white phosphorus, will ignite at temperatures close to room temperature.
Flammability Limits	Flammability limits are the lowest and highest concentrations (%) of vapors in air that will produce a flash fire when an ignition source is provided. Its unit of measurement is percent by volume in air. At a concentration too low to ignite, the mixture is too "lean" to burn. At a concentration too high to burn, the mixture is too "rich" to burn.
Flammable and Explosive	Flammable or explosive limits refer to the range of vapor concentrations in the air (percent by volume) that will burn or explode upon contact with an ignition source. The Lower Explosive Limit (LEL) is the lowest vapor concentration in the air which will explode if heated. The Upper Explosive Limit (UEL) highest vapor concentration in the air which will explode if heat is added. The explosive range between the LEL and UEL indicates the degree of hazard. The greater the range, the greater the hazard. The LEL is an important factor to be considered when calculating the volume of air needed to ventilate an enclosed space to prevent fires and explosions.
Oxidizer	A chemical which gives off oxygen. Oxygen feeds fires, and can cause materials that are normally hard to burn to burn more easily and at higher temperatures. Oxidizers should never be stored near flammable or combustible materials.
Extinguishing Media and Procedures	Extinguishing media specific to the particular chemical compound must be identified on the MSDS. Common extinguishing agents include water, foam, halon, carbon dioxide, dry chemicals, and powders. Any special procedures that may be useful to fire fighters and other emergency response personnel (i.e., Do Not Use Water) should be reported.

SECTION V - HEALTH HAZARD DATA

This section of the MSDS introduces a variety of information to help the Operational Level Responder understand the effects of exposure. All chemicals can be handled safely and the human body can, and does, withstand low level exposures to toxic compounds. This section will provide an interpretation of "low level" exposures for the chemical compound. Key terms that are required in this section of the MSDS are listed in the following table:

Key Terms	Description
Routes of Exposure	Routes of chemical exposure include inhalation, ingestion, and absorption. It is important to identify any and all of the potential routes of entry for chemical exposure.
Exposure Signs	Exposure signs describe how an overexposed individual is most commonly affected by the chemical. This should include any obvious physical indications as well as any subjective complaints that can be reasonably attributed to the exposure, such as headaches, burns, rashes, difficulty breathing, and dizziness.
Acute and Chronic Health Hazard	Acute and chronic health hazard data should include any health hazards for which there is statistically significant evidence, based on at least one positive study, conducted in accordance with scientific principles.
Acute Exposure and Effects	Acute effects occur immediately or in a short interval after exposure. They are typically sudden and severe (illness, irritation, and/or death) and are characterized by rapid absorption of the material. Acute effects are usually due to acute short-term exposures.
Chronic Exposure and Effects	A chronic effect is one that develops slowly over a period of time, or which recurs frequently. Chronic exposure means a relatively low level of exposure which occurs over a relatively long period of time.
Aggravated Medical Conditions	Medical conditions that may be aggravated or worsened by exposure to a chemical must be identified on the MSDS. Such conditions may include high blood pressure, asthma and other chronic respiratory conditions, diabetes, allergies, skin disorders, and liver and kidney problems.
Emergency and First Aid Procedures	Emergency and first aid procedures must be specified on the MSDS for the purpose of providing information on the immediate steps to be taken in the event of a medical emergency, until a qualified medical professional can examine the victim.
Carcinogen	A chemical or physical agent capable of causing cancer.
LD-50	The dose of a chemical that will kill 50% of the test animals receiving it. The chemical may be given by mouth (oral), applied to the skin (dermal), or injected (parenteral). A given chemical will generally show different LD-50 values depending on the route of administration and the species of the test animal. This measures acute toxicity.

SECTION VI - REACTIVITY DATA

Reactivity data includes information on chemical stability, incompatibility, decomposition, conditions to avoid and hazardous polymerization. The MSDS should indicate whether the chemical is stable or unstable under reasonable conditions of storage, use, or misuse. It also should indicate whether or not the chemical will react readily with air or change its chemical structure when exposed to various combinations of temperature, pressure and light conditions. MSDSs should identify those conditions to be avoided when handling unstable chemicals. The table below provides a description of the terms used in the reactivity data section of the MSDS.

Key Terms	Description
Stability	A material's ability to remain unchanged. The substance is considered stable if it remains in the same form under reasonable conditions of storage or use. Conditions which may cause dangerous changes are stated on the MSDS. High temperatures or shock from dropping can cause violent reactions.
Reactivity	The ability of a substance to undergo a chemical change, by reacting with other substances or by decomposing. Either change can create a potentially hazardous chemical.
Incompatible Materials	Incompatible materials are chemicals or materials that can initiate a potentially dangerous reaction when brought into contact with an otherwise stable substance. The MSDS should identify any such incompatible materials and their attendant hazards.
Hazardous Decomposition	Hazardous decomposition is the breakdown of a chemical substance into simpler chemical products. If the decomposition products are hazardous, the MSDS should explain the conditions that may cause decomposition and name the by-products.

Hazardous Polymerization	Hazardous polymerization is a chemical reaction where molecular units of a chemical bond together under certain conditions, to form a long chain called a polymer. Hazardous polymerization may occur when a reaction takes place at a rate that releases enough energy in the form of heat to cause a fire or explosion. Some chemicals can expand and burst their containers during a polymerization reaction. To help prevent hazardous polymerization, information about time period for which the chemical inhibitor will remain effective must be noted on the MSDS.

SECTION VII - SPILL, LEAK, AND DISPOSAL INFORMATION

Proper precautions for the safe handling and use of a chemical product must be indicated on the MSDS. This includes the steps to be taken in case the material is released or spilled, appropriate waste disposal methods, precautions to be taken in handling and storing the material, and any other safety precautions.

Response procedures for the cleanup of leaks, spills and other accidental chemical releases may include:

- Remove sources of ignition
- Avoid breathing of gases and vapors
- Provide additional ventilation
- Avoid contact with liquids and solids
- Isolate contaminated areas
- Evacuate unauthorized personnel
- Dike materials for spills
- Knock down vapors with water spray
- Apply absorbent material
- Sweep and decontaminate all areas

Appropriate waste disposal methods should also be specified on the MSDS for wastes that are created during spill cleanup and/or production operations. All waste should be disposed of in accordance with Federal, state, and local regulations. The MSDS will never provide specific information about proper disposal because of the potential for a variety of waste stream contaminations and the variation in local and state requirements. All hazardous waste in the shipyard should be segregated and processed in the central accumulation area for proper disposal.

SECTION VIII - CONTROL MEASURES AND SPECIAL PRECAUTIONS

This section of the MSDS requires information on the recommended control measures for reducing worker exposure to the hazardous substance. Some of the control measures may be described are:

Key Terms	Description
Ventilation and Engineering Controls	Engineering controls are the workers first line of defense against chemical exposures in the workplace. Ventilation systems, special enclosures, and other mechanical protection systems are all examples of engineering controls. Ventilation systems may be of the local exhaust type, which captures and removes contaminants at the source or the general dilution type, which reduces contaminant levels by circulating fresh air through the work environment. The MSDS can indicate whether these or any other types of specially designed ventilation systems are of use in the workplace.

Personal Protective Equipment (PPE)	Personal protective equipment (PPE) usually includes gloves, safety glasses or goggles, face shields, aprons, boots, and respiratory equipment. Specific information should be given on the exact type of respiratory protection to be worn for every possible level of exposure. Protective gloves and eye glasses are available in a variety of materials. The MSDS should specify a certain type of eye protection or glove material to be used with any given chemical. Any other special protective clothing or equipment that is known to the manufacturer should be noted on the MSDS.
Other Hygiene Information	Any relevant hygienic and/or work practices which can be employed to protect employee health and safety should also be reported.

SECTION XI - LABELING

This section generally provides precautionary statements that also appear on the chemical container label. This is very useful as it brings a primary source of information, the label, together with the technical information on the MSDS. It also provides other information for emergency responders, in the event of a spill, release, or contamination. Some other information is as follows:

- DOT shipping name
- United Nations Shipping Number
- Precautionary statements (Statement of Hazards) (Signal Word)
- NFPA Hazard Ratings
- HMIS Hazard Ratings

Session 9. Introduction To OSHA
Personal Protective Equipment (PPE) Requirements

OSHA's Hazardous Waste Operations and Emergency Response (HAZWOPER) standard (29 CFR 1910.120) specifies requirements for an acceptable Personal Protective Equipment (PPE) program. PPE is very important in the shipbuilding industry due to the diversity and potentially hazardous production operations. The requirements for PPE include:

1. Site hazards
2. PPE selection
3. PPE use
4. Work mission duration
5. PPE maintenance & storage
6 PPE decontamination
7. PPE training & proper fitting
8. PPE donning & doffing procedures
9. PPE inspection
10. PPE in-use monitoring
11. Evaluation of the program effectiveness
12. Limitations during temperature extremes

A complete PPE program should include records and documentation of all maintenance and training. Records recommended by the American Industrial Hygiene Association (AIHA) include:

- Industrial hygiene monitoring data
- Medical surveillance and job assignment data
- Respirator care and maintenance records
- Emergency equipment and maintenance tags

Personal Protective Equipment (PPE) and Chemical Protective Clothing (CPC)

Many factors must be considered when selecting Chemical Protective Clothing (CPC). The predicted type, measured concentration and toxicity of a chemical substance, in the ambient atmosphere, must be determined. The resistance of CPC material to permeation, degradation, and penetration must be considered. The potential for exposure to substances through inhalation or skin contact should be evaluated. The type and level of protection must be selected based on judgment and previous experience. When in doubt, response personnel should use the maximum level of protection indicated for the specific incident.

Shipyard workers and emergency response personnel involved with hazardous materials and wastes may be exposed to many types and forms of chemical substances. These substances may include acids, alkalines, chlorinated flammables, oxidizers, compressed gases, dusts, mists and fumes. The primary way that response workers can protect themselves is by using the appropriate protective clothing and respirators. When in doubt, check with your supervisor or a health and safety professional before using PPE.

The descriptive material in this section is designed to assist you in selecting and caring for various forms of personal protective equipment (PPE) . Anyone selecting PPE must be certain that the types selected are correct for the job. Users of PPE must be instructed on the following:

1. Proper usage
2. PPE limitations
3. Proper fitting procedures
4. Proper care, and maintenance

Throughout this manual and in common language CPC and PPE are used as interchangeable ideas. Chemical protective clothing acts as a barrier between the skin and chemicals that may damage the

skin or get through the skin to damage other tissues and organs. In order to protect from dangerous chemicals, protective clothing must be able to resist:

1. Penetration
2. Degradation
3. Permeation

1. Penetration: The term penetration is used to describe the ability of chemicals to penetrate through protective clothing seams, separations (i.e. where gloves, boots, and respirators meet the protective garment), stitch holes, zippers and button holes. When donning protective clothing these areas should always be inspected to determine if the garment meets the manufactures specification of design. A good way to inspect areas of potential penetration is to hold the garment up towards the light. If light shows through then the garment will be subject to penetration. In many cases, areas such as where gloves meet the sleeve or where respirators meet a coverall hood, are taped to reduce the potential for penetration. Many protective garments are equipped with flaps over zippers to reduce penetration. Another way of reducing penetration is to pull sleeve and ankle elastic bands over the gloves and boots. Do not tuck legs inside boots, this will enable chemicals to be spilled or splashed into the boots.

2. Degradation: Degradation is the term used to describe a chemical attack on the construction materials of protective clothing. Degradation may cause the material to dissolve, swell, become brittle or crack. Rates of permeation and penetration are increased as protective garments degrade. In simple terms, degradation destroys the physical appearance of the garment. Degradation is usually a function of equipment age, amount of usage, maintenance practices, time in the sun, amount and type of chemical exposure and overall equipment durability.

3. Permeation: Permeation is the term used to describe the ability of a chemical to penetrate a construction material of a protective garment. Some chemicals will permeate protective garments very quickly, while the same chemical may not have the ability to permeate a different material. When selecting protective clothing or other equipment, particularly respirators, health and safety personnel must determine the compatibility of protective garment construction material and the chemicals present in the work environment. Materials have various rates of permeation, which are determined by a laboratory permeation test. Many manufacturers provide permeation charts for their products to illustrate compatibility and rates of permeation. Other references concerning permeation and selection of PPE can be obtained from the American Conference of Governmental Industrial Hygienists (ACGIH) or the American Industrial Hygiene Association (AIHA).

Controlling Hazards in the Shipyard With Personal Protective Equipment

The use of PPE is generally a last resort procedure applied to a general shipyard worker to minimize exposure to potentially toxic materials and other hazardous conditions. The main reason that PPE is a last resort is because it can be very bulky and hot, which can put the worker in danger of heat stroke and exhaustion. However, during emergency response situations, PPE will always be used because of potential unknown situations and chemicals in an emergency incident. There are three ways to control exposure to dangerous chemicals:

1. **Engineering Controls:** An engineering control involves changing the work process to make it safer and more healthful. This method of control is usually the most effective for protecting employees from chemical exposures. It is the best alternative because it does not require the worker to don cumbersome PPE. Examples of engineering controls include:

- Substituting a less toxic chemical for a hazardous chemical (i.e., less toxic solvents)
- Changing machinery design to eliminate or reduce hazardous exposures (i.e., shear vs. grind)
- Using a local ventilation system sufficient to remove the hazards from the work area

2. **Administrative Controls:** Administrative controls involve reducing, rotating or changing the work assignment of each exposed worker. The goal is to reduce the amount of total exposure to a hazard. For example, an acceptable exposure to a certain solvent cleaning operation my be two hours in an 8 hour period. If possible, the shipyard would assign 4 different workers for two hour shifts. If this was not possible, the shipyard would apply PPE to minimize exposure.

3. **Personal Protective Equipment:** Personal protective equipment (PPE) is the least desirable control method because it can be hot and uncomfortable. PPE is used when engineering and administrative controls cannot completely eliminate the hazard.

PPE Can Protect The Whole Body

Shipyards are one of the most dangerous types of work places due to of the wide variety of hazards. The best way to protect yourself is by paying attention to what you are doing and taking the proper protective precautions. In some cases the proper precautions include the use of Personal Protective Equipment (PPE). The best source of information on the selection, care, and use of personal protective equipment is available at the Shipyard Safety Department. PPE can provide some protection for the workers, from head to toe, as displayed in the following table and sections:

Area of Protection	Equipment
1. Head protection	Hard hats, helmets, hoods
2. Hearing protection	Ear plugs, ear muffs
3. Eye and face protection	Safety goggles, face shields, safety glasses
4. Respiratory protection	Air purifying respirators (APR), SCBA, particulate filters
5. Hand protection	A wide variety of work gloves
6. Body protection	Coveralls to total body encapsulation
7. Feet protection	Steel toed boots and chemical protective boots

1. Head Protection

Head protection is very important, especially in an emergency situation. Hard hats are the most widely used and acceptable method of head protection. They offer protection where there is a potential hazard from striking one's head on low-hanging objects or from impact from falling objects. Hard hats are standard shipyard worker equipment. A hard-hat equipped with a chin or nape strap, is strongly recommended during most spill management situations.

2. Hearing (Ear) Protection

Ear protection plugs are standard issue in the shipyard due to the potential excessive noise in the construction areas. There are a variety of ear plugs available that are applicable to various noise levels, work duration, and comfort. A safety professional should be consulted before selecting the proper equipment.

3. Eye and Face Protection

Safety Glasses - Industrial types of eye protection must be worn by all Shipyard Workers assigned to areas where there is exposure to flying particles, molten metal, airborne dust, or excessive radiant energy. Tempered safety glasses with side shields are the minimum requirement for shipyard operations.

Impact Goggles - These goggles are recommended for eye protection against projectiles weighing up to 0.1 ounce. Projectiles can be produced by the failure of various machine tools such as drill bits, grinding wheels, and similar equipment. Impact goggles do not protect against chemical splashes or radiation from welding operations.

Chemical Splash Goggles - These goggles are recommended for protection against chemical splashes and airborne mists, vapors, and fumes. Chemical splash goggles do not provide adequate protection where there is a risk of exposure to the entire face and neck area (i.e., transfer of bulk acids or spills of hazardous liquids). Goggles should typically be used in conjunction with a full face shield.

Welding Goggles and Hoods - Special protection is needed to protect against intense radiant energy, especially ultraviolet and infrared radiation, molten metal, slag, and flying particles. Welding goggles protect the workers eyes, while the welding hood is designed to protect the workers face and neck area. In some circumstances welding may also require the use of a respirator.

Face-Shields - Face-shields are recommended for eye and face protection against splashing chemicals, flames, molten metals, hot liquids, cryogenics, and flying particles. Chemical splash goggles must be worn in conjunction with face-shields when handling and cleaning up strong corrosives or any bulk hazardous substances.

When Should Eye Protection Be Used In the Shipyard?

HAZARD	OPERATION	Eye and Face Protection
Harmful Radiation, Molten Metals	Welding, Brazing	Welding Goggles and Hoods
Splash, Acid Burns, Harmful Vapors	Bulk Chemical Handling and Hazardous Substance Clean-up	Chemical Splash Goggles Laser Goggles
Flying Particles	Chipping, Machining, Grinding (Light and Heavy), Spot Welding	Safety Glasses w/Side Impact-Goggles Chemical Splash Goggles
Sparks, Harmful Radiation, Molten Metals	Electric Arc Welding and Cutting	Welding Goggles and Hood
Glare, Heat from Molten Metals, Sparks and Splashes	Furnace Operations, and Molten Metals Operations	Welding Goggles and Hood Face Shield
Chemical Splash, Glass Breakage	Laboratory Situations (Photo Lab, Plating Operations, etc.	Chemical Splash Goggles Face Shield
Unknown Chemical Hazards	Hazardous Substance Emergency with Unknown Materials	Full Body Protective Shields

4. Respiratory Protection

Respiratory protection is one of the most important types of PPE due to the potential for inhalation of toxic vapors and fumes in a hazardous emergency situation. There are several types of respiratory equipment used in the shipbuilding and repair industry. Respiratory protection ranges from dust masks to full Self Contained Breathing Apparatus (SCBA). In normal working situations, it is easy to determine what type of respiratory protection is needed, due to the ability to continuously monitor the worker for exposure. On the other hand, in an emergency situation, it is difficult to

determine what type of respiratory equipment is needed. The following table lists some of the typical respiratory hazards and several types of applicable respirators.

Respiratory Protection	
Types of Hazards	Toxic Fumes Gaseous Chemicals Reaction By Products Dust

Types of Personal Respirators Available	Dust Protection Masks
	Air Purifying Respirators
	  Half Face Cartridge Type: Use Correct Cartridge
	  Full Face Cartridge Type: Use Correct Cartridge
	  Disposable Cartridge Type
	Self Contained Breathing Apparatus (SCBA)
	Supplied Air Breathing Apparatus (SABA)

In general, SCBA is the best respiratory protection for managing chemical spills. However, cartridge type, or approved disposable units, may be acceptable if the concentration of oxygen in the air is over 19.5%, and if no chemical is present above the "Immediately Dangerous to Life and Health" (IDLH) level. It may be necessary to perform air monitoring prior to entering a hazardous substance emergency situation. Do not rush into a emergency situation with out respiratory protection if you suspect potentially toxic fumes.

Air Supplied Respirators - Deliver breathable air through a supply hose connected to the wearers face piece. The air delivered must be free of contaminants or must be from a source located in clean air. The two types of commonly used air supplied respirators are the compressed air line and the self-contained breathing apparatus.

Air Line Supplied Respirators **-** Connected to a suitable compressed air source by a hose that the wearer trails behind. The air is delivered continuously or intermittently to the wearers face mask. In addition, for atmospheres or environments categorized as immediately dangerous for life and health (IDLH) or for rescue operations, an airline respiratory system must be equipped with a 5-minute escape supply and be a pressure-demand type.

Self Contained Breathing Apparatus (SCBA) **-** Provides complete respiratory protection against toxic substances and oxygen deficiencies. The oxygen or air supply apparatus is portable and is carried by the wearer. It is fastened from the portable tank, via a pressure regulator, to the face piece. SCBAs are limited in use by the capacity of the air storage tank. Normally, air tanks have a 30-minute capacity, with a low-level alarm that signals when the tank reaches the last 5 minutes of air supply. This is the only system recommended for rescue operations or work areas classified as Immediately Dangerous to Life and Health (IDLH).

Air Purifying Respirators (APRs) - These respirators cleanse the contaminated atmosphere by passing the air through a mechanical or chemical cartridge filter designed to remove specific contaminants. These devices are limited to those environments where there is sufficient oxygen to sustain life and the contamination levels are within the specified concentration limitation of the devices removal capacity.

5. Hand Protection - Selecting the Correct Glove

It is very important to use the correct type of glove to protect hands from chemical or physical damage. Gloves are the best form of hand protection to protect against sharp glass and metal,

chemical burns, thermal burns and chemical spills, splashes, and leaks. The table below illustrates the types of gloves available and their application in the shipyard environment:

Glove Type	Description
Leather Gloves	Used for hand protection against abrasions during general material handling. Leather gloves do not provide protection against sharp objects or chemicals.
Nylon (100%)	Used when handling parts with sharp or rough protrusions in clean rooms and assembly areas. Nylon offers no protection from chemical exposure and may dissolve on contact with some chemicals.
Neoprene	Hand protection against both weak and strong acids, (nitric, hydrochloric, sulfuric, hydrofluoric), Acetone, MEK, MIBK, soaps, and detergents. Neoprene gloves are bulky and are not suitable for prolonged exposure to halogenated or aromatic solvents.
Buna-N (Nitrile)	Protection against aliphatic solvents, including Freon, isopropyl alcohol, epoxy resins, and PCBs. Limited protection is provided against halogenated solvents. Nitrile gloves are not suitable for use with ketones, such as acetone, MEK, or MIBK.
Polyvinyl Chloride (PVC)	Very good for protection against caustics such as ammonium hydroxide, sodium hydroxide, and potassium hydroxide. PVC gloves are not suitable for use with halogenated solvents or ketones.
Viton Elastomer	Protection against aromatic solvents, such as toluene and xylene, and for halogenated solvents, such as methyl chloroform or methylene chloride. Do not immerse in halogenated solvents for more than 30 minutes.
Kevlar Gloves	Protection against extreme hot or cold temperatures and materials. Kevlar also provides abrasion and cut protection. These are only suitable for use in the temperature range -400^{o}F through 1000^{o}F. These gloves are not for chemical use.
Butyl	Used for hand protection against strong oxidizers (red fuming nitric acid, gaseous fluorine and chlorine, and concentrated hydrogen peroxide). Butyl also protects against dimethyl sulfoxide. Butyl gloves are very bulky and limit manual dexterity.
Latex	Used for radioactive materials. These gloves also are good underliners for other gloves. A heavy duty latex glove are available to provide improved cut and abrasion protection.
Neoprene-Latex Blend	Good for protecting hands against dilute (less than 5%) acid or caustic solutions. Under these conditions, these gloves have no limitations.
Ceramic Mesh Gloves	Provides good protection against abrasions and lacerations and is recommended for handling sharp materials, such as banding or handling scrap, or when using a box knife.
Polyvinyl Alcohol (PVA)	Provide protection against halogenated solvents such as trichloroethane or methylene chloride. They must never be exposed to water or moisture. They must not be used with water-dispersed or water-based chemicals. PVA gloves are bulky.
Steel Mesh Gloves	This glove provides good protection against abrasions and lacerations and is recommended for handling sharp materials, such as scrap, or when using a box knife.

The following list gives examples of the appropriate glove to use for various chemicals:

Chemical	Best Glove	Second Best Glove	Do Not Use
1. Gasoline or combustible diesel"	Nitrile Rubber Viton	"Silver Shield" Neoprene, PVC	Natural Rubber
2. Hydrochloric Acid (37%)	Nitrile Rubber Neoprene, PVC	"Silver Shield Natural Rubber	None
3. Methyl Ethyl Ketone (MEK)	None (chemical can pass through all types)	"Silver Shield Natural Rubber, PVA	PVC, Nitrile Rubber Neoprene
4. Methylene Chloride	None	"Silver Shield", Viton, PVA	Natural Rubber, Nitrile Rubber, Neoprene, PVC
5. Sodium Hydroxide(50%)	Natural Rubber, Nitrile Rubber, Neoprene	"Silver Shield" PVC	None
6. Sulfuric Acid (47%)	Nitrile Rubber, Neoprene, Natural Rubber	"Silver Shield" PVC	None

6. Properties of Common Chemical Protective Materials

There is a wide variety of protective clothing available for the shipyard work environment. The type of clothing will be largely dependent on the chemicals that will be handled and the work at hand. As mentioned earlier, protective clothing is manufactured from many different fabrics, and may be resistant to degradation from many chemicals. Some fabrics, however, may not be resistant to petroleum compounds and halogenated compounds, (i.e. butyl rubber). This is a common drawback of many protective fabrics. In addition, fabrics that are less expensive may have more limitations. Expensive fabrics found in fully encapsulating suits, gloves and boots, may be more effective to use against permeation from vapors or gases.

Elastomers (polymeric materials that, after being stretched, return to about their original length), provide the best protection against chemical degradation, permeation, and penetration from toxic and corrosive liquids or gases. Elastomers are used in boots, gloves, coveralls, and fully encapsulating suits. They are sometimes combined with a flame-resistant fabric called "Nomex" to enhance durability and protection. The abilities of elastomers to resist degradation and permeation range from poor to excellent. The selection of a particular material should be based on its resistance to chemical degradation, as well as its ability to resist permeation and the other performance characteristics.

There are a wide variety of protective materials. The following is a list of the more common materials used in chemical protective clothing. The classes of chemicals rated as "good for" or "poor for" represent test data for both permeation breakthrough and permeation rate. They are general recommendations with exceptions in each chemical class.

Protective Material	Good For:	Poor For:
Butyl Rubber (Usually Black) (Isobutylene/Isoprene Copolymer)	Bases and many organic chemicals, heat and ozone resistance, decontamination	Aliphatic and aromatic hydrocarbons, gasoline, halogenated hydrocarbons, abrasion resistance
Neoprene: (Usually Orange) (Chloroprene)	Bases and dilute acids, peroxides, fuels, and oils, aliphatic hydrocarbons, alcohols, glycols, phenols, abrasion and cut resistance	Halogenated hydrocarbons, aromatic hydrocarbons, ketones, concentrated acids
Nitrile Rubber (Usually Blue) (Acrylonitrile Rubber, Buna-N, Hycar, Paracril, Krynac)	Phenols, PCB, soils, fuels, alcohols, amines, bases, peroxides, abrasion and cut resistance, flexibility.	Aromatic and halogenated hydrocarbons, amides, ketones, esters, cold temperature
Polyurethane (Usually Tan or Yellow)	Bases, aliphatic hydrocarbons, alcohols, abrasion resistance, flexible - especially at cold temperatures.	Esters, ethers, acids and bases
Polyvinyl Alcohol (PVA) (Usually Red)	Almost all organic and ozone resistance.	Esters, ethers, acids and bases, water and water solutions, and flexibility
Polyvinyl Chloride (PVC) (Green)	Acids and bases, some organic amines, and peroxides.	Most organic compounds, cut and heat resistance
Viton (Usually Jet Black)	Aliphatic and aromatic hydrocarbons, halogenated hydrocarbons, acids, and decontamination oxidizers.	Aldehydes, ketones, esters (oxygenated solvents), and amines

Teflon (Usually White)	Teflon has become available for chemical protective suits and provides excellent chemical resistance against most chemicals.	
Tyvek: (Non-Woven Polyethylene Fibers) (Usually White Standard)	Dry particulate and dust protection, decontamination, disposable, lightweight, tear, puncture and abrasion resistance. Used against toxic particulates but provides no chemical protection; worn over other chemical protective clothing to prevent gross contamination of non-disposable items and under suits to replace cotton.	Chemical resistance (penetration/degradation) durability
Polyethylene: (coated Tyvek) (Usually Yellow)	Acids and bases, alcohols, phenols, aldehydes, decontamination, disposable, and lightweight. Provides limited chemical protection against concentrated liquids and vapors. Useful against low concentrations and those activities that do not create a high risk of splash; also worn over chemical protective clothing to prevent gross contamination of non-disposables.	Halogenated hydrocarbons, aromatic hydrocarbons, physical properties (durability), and penetration (stitched seams)
Saranex (laminated Tyvek) (Usually Light Gray)	Acids and bases, amines, some organics, PCBs, decontamination, disposable, lightweight and durability.	Halogenated hydrocarbons, aromatic hydrocarbons stitched seams and penetration may occur
Flame Retarding Urethane:	Resistant to a number of materials such as aliphatic solvents, oils and alcohols. Provides good resistance towards flame.	
Nomex: Dupont Aromatic Polyamide Fiber	Non-combustible and flame resistant up to 220^{o}C, thus providing good thermal protection. Very durable and acid resistant. Used in fire fighters' turnout gear and some fully encapsulating suits as a base for the rubber.	

7. Foot Protection

Boots are designed to provide protection from sharp objects, hazardous substances, bruising, and crushing. For hazardous chemicals, leather boots are not acceptable. Work boots, with protective coverings or chemical protective boots that also provide mechanical and slip protection are required. Boots that become contaminated must not be removed from the work area unless decontaminated. Contamination on the sole of boots is a major source of spread of such contamination.

Chemical Protective Clothing (CPC)

There are hundreds of chemicals that can affect the physiological health of shipyard emergency response personnel. A chemical exposure can cause both short and long term health effects, and may be fatal.

To properly handle a hazardous substance incident, it is imperative that response personnel understand the proper protective clothing. CPC or PPE is the first line of protection for emergency responders. Selection criteria, as well as proper ensembles, have been established for each level of protection when the following situation occurs:

- Response activities involve known or suspected atmospheric contamination
- Vapors, gases or particulates may be generated by site activities
- A possibility of direct contact with hazardous or toxic substances through skin absorption
- The substance itself, or the hazards involved, are unknown

NFPA Chemical Protective Clothing Standards

The National Fire Protection Association (NFPA) has created three CPC standards that specify minimum documentation, design criteria, performance criteria and test methods for protective suits. When these NFPA standards are quoted as specifications in a typical purchase order, the manufacturer must provide a suit constructed in accordance with these standards. The suit must meet a uniform standard, and must also be appropriate for the expected level of performance. These standards provide the emergency responder with a clear and precise definition for various levels of chemical protective clothing. The NFPA standards for CPC are found in the following documents:

1. NFPA #1991 - *"Vapor-Protective Suits for Hazardous Chemical Emergencies"*
2. NFPA #1992 - *"Liquid Splash-Suits for Hazardous Chemical Emergencies "*
3. NFPA #1993 - *"Support Function Protective Garments for Hazardous Chemical Operations "*

These standards are very rigid. They include a strict set of tests and requirements that the suits must meet in order to earn NFPA approval. They provide a basis for standardizing construction of the suits, and for establishing a high level of quality control.

Prior to purchasing CPC, emergency response personnel should evaluate CPC test results. All data generated in the tests must be published and provided to the purchaser in a booklet entitled "Technical Data Package" for all CPC garments meeting NFPA standards. The Technical Data Package must contain a full and accurate description of all materials and components used in the assembly of the chemical protective garment including:

Primary suit material
Gloves and assembly
Zipper or closure assembly
Exhaust valves
External gaskets
Visor/face shield
Boots and assembly
Seams, types and composition
External fittings

The Technical Data Package must also contain information on:

- Cleaning instructions
- Marking and storing suggestions, frequency and details of inspections, maintenance criteria
- Use of testing equipment
- Methods and procedures for repairs, warranty information

The manufacturer shall provide the following information to the garment purchaser:

- Donning and doffing instructions
- Safety considerations
- Storage conditions
- Recommended shelf-life
- Decontamination recommendations
- Retirement considerations
- Closure lubricants
- Visor and anti-fog agents

The individual laboratory test results section is probably the most important part of the package. Test results are documented in this section. These ASTM tests will yield information on performance regarding the following:

- Chemical permeation (or penetration)
- Flammability
- Puncture
- Tears
- Abrasion
- Flex/fatigue
- Exhaust valve inward leakage
- Cold temperature
- Overall suit water tightness
- Suit closure penetration

Each ASTM test must be conducted on each and all principal parts of the chemical suit including suit material, visor, gloves, boots, seams, zippers or suit closures.

NFPA "Vapor-Protective Suit" (Level A Suit)

"Vapor-Protective Suits" are designed to provide the highest level of protection available against vapors, gases and liquids. The intent is that the suit be worn any time the chemical is present at or above the IDLH concentration. SCBA should be worn on the inside of the suit.

To meet NFPA Standard #1991, the suit must pass a very rigid set of chemical permeation tests, involving 21 specific chemicals. This includes anhydrous ammonia and chlorine gas, and any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit. All parts of the suit including the gloves, visor, boots and seams are subjected to all 21 chemicals. Permeation resistance shall not exceed normalized breakthrough times of one hour for each chemical in the test.

The efficiency and performance of the suit during permeation resistance tests must be documented in a user's "Technical Data Package." This booklet must accompany every suit that earns the NFPA certification. It must contain all of the data regarding the success or failure of permeation to all parts of the suit.

Vapor-protective suits are the most expensive. Costs can range from $1,000 to $5,500 each. Generally the material used for vapor-protective suits is quite heavy, and of high quality.

NFPA "Liquid-Splash Protective Suit"

A "Liquid-Splash Protective Suit" is designed to protect emergency response personnel against exposure to specified chemicals in liquid splash environments during hazardous chemical emergencies. It is not approved for protection against gases and vapors, and should never be worn in place of a vapor-protective suit. They should never be worn if the chemical is present at or above the IDLH concentration.

Liquid-splash protective suits can allow SCBA to be worn on the inside or the outside. The suits can be one, two, or three-pieces, and may come with or without gloves and booties. Wrists and ankles usually have to be banded. They are usually less durable and do not have as high a chemical resistance rating as the vapor-protective suits. The suits may provide for good penetration

resistance, but might have very poor permeation resistance. These suits are *not* tested for permeation resistance.

These suits must also undergo specific testing, though the requirements are not as extensive as they are for the vapor-protective suits. To meet NFPA Standard #1992, the suit must pass a set of chemical penetration tests against an NFPA battery of test chemicals, plus any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit. There must be no penetration detected within one hour of exposure.

NFPA "Support Function Protective Clothing"

"Support Function Protective Clothing" is designed to provide limited, short term, protection against liquid and powder chemical hazards only. They must never be used for protection against vapors and gases, and never used in an environment where the chemical is present at, or above, IDLH levels. This suit is essentially a cheap throw-away version of a splash-protective suit.

Support function protective clothing is very popular because they are low cost, totally disposable, easy to don and doff, light weight and cooler to wear. They are often used for hauling waste and other waste operations, repacking operations, sample taking, field identification, some decontamination procedures and response team training. They can be ordered to allow SCBA to be worn on the inside or the outside. They may come as one, two, or three-piece suits.

Levels of Chemical Protective Clothing

Sometimes workers may only need minimum protection and other times they may need maximum protection. The EPA has established four levels of protection when working with hazardous materials and responding to hazardous material incidents. The four levels are identified as Levels A, B, C, and D. The level of protection required will depend on the type of work to be performed and working conditions. The worker should decide how much protection is needed (the level of protection) based on; 1) The type and concentration of the chemical in the workplace, or the emergency site, and its toxicity; and 2) The potential for exposure to hazardous substances in air, splashes of liquids, or other direct contact.

Different Levels of Protection refer to a full ensemble of protective equipment (i.e., protective garment, boots, gloves, SCBA). For example: A liquid-splash protective suit ensemble when used with SCBA would provide Level B protection. The same suit used with an air-purifying respirator would be Level C protection. Various combinations of personal protective equipment other than those described for Levels A, B, C, and D protection may be more appropriate, and may be used to provide the proper level of protection.

The four levels are defined as follows:

LEVEL	DESCRIPTION
LEVEL A	The highest level, Level A, consists of a highly impermeable fully airtight encapsulating suit and all necessary support equipment, including Self-Contained Breathing Apparatus (SCBA) or supplied air breathing apparatus.
LEVEL B	The normal minimum for initial penetration into a hazardous spill area. Level B consists of SCBA, full chemical protective clothing, such as Saranex coveralls, and associated support equipment similar to Level A.
LEVEL C	This level is similar to Level B except that an air purifying respirator is used instead of supplied air. Level C is acceptable when known chemical exposures are less than the IDLH level and the proper respirator can be applied effectively.
LEVEL D	This level represents normal work clothing, such as lab coats and minimal splash goggles. This is the general attire of Operational Level Responders.

The following conditions have been established for each level of CPC:

Level	Conditions for Use
A	Confined space entry High potential for splash or immersion Skin destruction or dermal absorption threat IDLH dermal High concentrations of vapor, gases or particulates
B	High respiratory threat Less than 19.5% 02 Minimum level for initial assessment of unknown spills Only moderate splash threat Non-IDLH dermal
C	No IDLH dermal or respiratory threats All contaminants known Air purifying respirator requirements met
D	No known hazards Work functions preclude chemical exposure Provides basic safety at an incident Allows for quick upgrade to higher levels

The actual clothing and equipment will vary slightly from Level to Level and the main differentiation for emergency response is focused on air quality and the type of respirator needed. The following table provides an itemized list of components for the four levels.

PPE Level	PPE Components of the Ensemble
Level A	Positive pressure, self contained breathing apparatus (SCBA) * * Pressure demand airline with escape bottle * * Totally encapsulating chemical protective (TECP) suit * * Inner coveralls and long underwear * Inner and outer chemical resistant gloves and boots Hard hat (depending on scope of work) Cooling apparatus * Radio communications *
Level B	Positive pressure, self contained breathing apparatus (SCBA) * * Pressure demand airline with escape bottle * * Non-encapsulating chemical protective suit * * Inner coveralls and long underwear * Inner and outer chemical resistant gloves and boots Hard hat (depending on scope of work) Radio communications *
Level C	Air purifying respirators with a full-face cartridge or canister capable of filtering out the contaminants associated with the tasks at hand Non-encapsulating chemical protective suit Coveralls and long underwear * Inner and outer chemical resistant gloves Boots (steel toe and chemical resistant with disposable boot covers) Hard hat (depending on scope of work) Radio communications *
Level D	Normal work uniform Dust respirator * Coveralls Work boots Safety glasses and hard hat

* Optional

* * Supplied Air Respirators must be approved by the Mine Safety and Health Administration (MSHA) or the National Institute for Occupational Safety and Health (NIOSH)

One of the most important things to understand is when a worker should wear a certain level of protection. The table below briefly describes the requirement for each of the four levels:

	When Should Each Level Be Warn?:
Level A	Should be worn when the highest level of respiratory, skin, and eye protection is needed. Level A is needed when chemicals and concentrations are totally unknown and there is a potential for IDLH situations. Level A should also be worn in emergency situations, where high concentrations of toxic dusts, mists, fumes, gases and vapors are expected, as well as exposures to unidentified chemicals, and a high potential for splash or immersion exists. Similarly, Level A should be worn in confined, poorly ventilated areas that have not been approved for lower levels of protection.
Level B	Should be worn when the highest level of respiratory protection is needed, but skin protection is not as important. Level B is the minimum level of protection that should be worn to enter a site where the hazards have not yet been identified. For example, in emergency response situations where the type of chemical and concentration possibilities of contact are not known. A minimum of Level B should be worn until the hazards can be better identified during site characterization and analysis.
Level C	Should be worn when the criteria for using air purifying respirators (APR's) are met. For example, when the air contaminants have been identified and APR will be effective protection (not IDLH conditions). Level C should also be used when the airborne contaminants, liquid splashes, and other direct contact will adversely affect, or be absorbed through, exposed skin. Level C provides the same skin protection as Level B, but less respiratory protection.
Level D	Should be worn only as a work uniform when there are no suspected respiratory or skin hazards. Level D provides very little skin protection and no respiratory protection. Therefore, Level D is only used when work functions do not include splashes, immersion or potential for unexpected inhalation of, or contract with, hazardous levels of any chemical.

Donning the Chemical Protection Ensemble

Standard routines should be established, written, and practiced for donning each level of protective equipment. Donning (and doffing) of all chemical suits is difficult and almost impossible to perform alone. Therefore, it must be done utilizing the "buddy system". Solo efforts may increase the likelihood of damage to the suit, and increase the chance of errors. The buddy simultaneously looks for damage to all equipment and ensures that all safety steps and procedures are being followed. The wearer must have confidence that his/her assistant will meticulously carry out these steps. There can be many phases to assembling and donning CPC:

- Donning the suit itself, including multi-piece suits.
- Arranging, the cooling system.
- Assembling a communications system.
- Providing for an inner or outer fire or flame protective garment.

Once the suit and equipment have been donned, the fit should be evaluated and inspected. If the garment is too small, it will restrict movement, thereby increasing the likelihood of tearing the suit. If the garment is too large, the possibility of snagging the material is increased, and the dexterity and coordination of the worker may be compromised.

Personal Use Factors

Certain personal features of workers may jeopardize safety during equipment use. Prohibitive or precautionary measures should be taken as necessary. All of the items listed below can be considered points of safety.

- Facial Hair: Facial hair or long hair may interfere with SCBA fit, and obstruct the wearers vision. Any hair that passes between the face and the sealing surface of the face-piece should be prohibited.
- Eyeglasses: Conventional eyeglasses will interfere with the SCBA face-piece seal and should be prohibited. A spectacle kit should be installed in the face-piece for workers requiring eye correction.
- Contact Lenses: Team members should not be allowed to wear contact lenses when wearing SCBA or a fully encapsulating suit. In the event of a dislodged or lost contact lens, the wearers safety suddenly becomes extremely compromised. The wearing of contact lenses while using SCBA is prohibited by CAL/OSHA in California.
- Chewing Gum: Any chewing product should be prohibited during SCBA use since they may cause ingestion of contaminants. If coughed up, they can clog portions of the SCBA face-piece.
- Jewelry: Earrings, rings, watches, arm bands and necklaces should be banned. Removal of all jewelry and personal adornment should be routine before the donning of SCBA and CPC.
- Personal Items: Wallets, badges, name tags, keys, lighters and other personal items should always be removed. These items can cause the CPC to become ripped or torn from the interior.

HazMat team members should adhere strictly to these guidelines. They are critical to the safety of all personnel. Team members should be trained to accept nothing that compromises their safety.

Response personnel must develop and understand the many protocols necessary to support the use of CPC. Donning and doffing procedures must be established and practiced. In addition, protocols and procedures should be established for determining working time, personal use factors, medical monitoring, work tolerance, documentation, and step-off procedures. Training in the use of established procedures and protocols is the key to safety when using CPC. Remember, the proper use of CPC may make the difference between life and death.

General Guidelines for Donning and Doffing CPC

How to don and doff CPC will vary slightly depending on the particular suits that are available. It is important to be familiar with the suits available in the department. The following guidelines should be kept in mind regardless of the particular suit you use.

It is important to have a systematic approach to donning and doffing CPC primarily so that nothing is forgotten. A systematic approach also helps minimize confusion, frustration, and time spent donning and doffing equipment. Having equipment laid out in an organized manner also helps to reduce the risk of damaging any of the equipment in the donning or doffing process. As indicated above, the checklists and CPC layout included in this chapter may be used as a guide, but these are only examples. Each shipyard should develop its own standard operating procedures based on the particular suits they use.

Response personnel should inventory and inspect all equipment prior to donning. Equipment should be inspected again after use. Equipment which is damaged or not functioning properly should be removed from service until it can be repaired by qualified personnel or replaced as needed.

An appropriate dress-out area should be selected for response personnel to don CPC. It should be an area where responders can be protected from the elements such as heat, wind or rain, and

located away from the exhaust pipes of response vehicles. It should be spacious enough to allow responders to lay out equipment in an organized manner and to don CPC without tripping over anything. It should also be a relatively quiet area so that responders are able to plan their activities with a minimum of distractions. If the area does not already have a place for personnel to sit, chairs should be provided. Media and other non-essential personnel should be kept away from the dress-out area.

Since personnel wearing CPC are likely to experience some level of heat stress, they should delay donning the equipment until just prior to making the entry. That minimizes the time they need to spend wearing the suits. If possible, a partner should be assigned to assist each person who will be donning CPC. This partner should do whatever "running around" is needed to locate and set up equipment so that the Entry Team member doesn't have to expend unnecessary energy before the entry. The partner should assist the Entry Team member with donning both SCBA and the suit itself. Personnel should also hydrate prior to donning CPC even if they do not feel thirsty. It is not uncommon for the suits to fog up during use, thus limiting visibility. Many HazMat teams will use an anti fog solution on the inside of both their SCBA masks and the suit face shield to help minimize this problem. Some responders will also attach a paper towel, or terry cloth towel, to their helmets so that they can wipe the inside of the suit face shield, if it begins to fog up.

Issues Affecting the Selection of PPE

There are many other factors to consider when selecting PPE other than chemical resistance and job function determinates, such as equipment compatibility and consistency, ease of usage, decontamination process, overall quality, and cost benefit. The following sections outline some concerns when purchasing and selecting shipyard PPE.

Purchasing Equipment: When purchasing equipment, it is important to consider consistency, capability, and compatibility. Generally, supplies of PPE should be purchased from the same manufacturer to increase the likelihood that all workers are trained on the same type and style of protective clothing and respirators. This consistency will ensure that all workers are familiar with the proper donning, doffing, use, decontamination, and maintenance procedures associated with the PPE. Generally, new equipment must be compatible with present equipment being used at the shipyard. For example, respirator cartridges sold by different manufacturers cannot be interchanged. Compressed breathing air tanks are not interchangeable with other brands, and in some cases, breathing air tanks are not interchangeable with other models from the same manufacturer. On the other hand, it is also important to understand that high pressure tanks cannot be interchanged with low pressure tanks built by the same manufacturer. Therefore, purchasing equipment from the same manufacturer will not ensure that the equipment is compatible.

Some manufacturers design a protective suit to be used with a specific type of respirator. There may be air line hookups or regulator viewing windows that are designed for a specific SCBA. Some suits include built-in hard hats while others accept only specific types or designs. When selecting new protective equipment, the HazMat Technician should, whenever possible, make sure the new equipment will be compatible with the safety equipment already in use.

Working Environment: The possibility of a protective garment being damaged or torn is low when a worker enters a emergency site during air monitoring and hazard characterization. On the other hand, if a worker is dismantling a barbed wire fence to gain access to a drum storage area, the possibility of a protective garment being ripped is much greater. Health and safety officers, site supervisors, and workers should perform periodic field inspections of protective clothing to ensure that the integrity is not lost due to tearing or other breakdown. The fabric thickness and weight

should also be considered when selecting PPE. The heavier the garment, the more stress is placed on the individuals using the equipment.

If a emergency response worker enters a burning chemical warehouse to remove drums being threatened by fire, the use of a fire resistant proximity suit and chemical protective clothing may be necessary. High temperatures, caused by fire or ambient temperature, increases the reaction rate of chemicals with protective garments. This will also increase the rate of penetration, permeation or degradation of protective clothing. It may be wise to obtain information concerning the temperature in which permeation tests were performed. The temperature may effect the garment pliability of many plastic type materials, and cause them to stiffen at cold temperatures which will lead to cracking.

Decontamination Process: During hazardous waste site clean-up, or emergency response operations, protective equipment usually becomes contaminated. Ease of decontamination should be a high priority when selecting PPE. Many materials are porous and make it difficult to remove foreign substances. Difficulty with decontamination leads to excessive work requirements and the potential for unsatisfactory maintenance. Poor maintenance will lead to premature degradation of PPE. Due to the high cost of reusable equipment, it is more cost effective to use disposable equipment, whenever possible.

Monitoring equipment, air line hoses and other equipment can be wrapped in plastic sheeting to prevent gross contamination and limit decontamination requirements or the need to discard expensive equipment. Air lines used for supplied air respirators may have to be discarded if they have been dragged through toxic materials such as PCBs or dioxins. These air lines can be protected by wrapping them with plastic sheeting or covering them with plastic tubing. Low cost disposable tubing is available for this type of application. Airlines should be monitored closely by field personnel to ensure that hoses are not cut by moving equipment or other site conditions.

Concentration Of Chemicals to be Encountered: The concentration of chemicals plays a significant role when determining permeability. The higher the concentration of a chemical, the more rapid the rate of permeation. Permeation tests are performed using concentrated chemicals. Therefore, when selecting construction materials of protective clothing, the concentration of the chemical in question should be known. In many cases, a dilute solution will decrease the permeation rate of a particular chemical to garment construction material. Mixtures of chemicals may also play an important part in selecting protective clothing. A garment may be very resistant to one chemical in a mixture and completely incompatible with the other chemical. Workers may then be required to wear two different types of coveralls. For example, polyvinyl alcohol (PVA) will provide excellent protection from exposure to solvents such as toluene or xylene, however, is not resistant towards water based chemicals.

Material Types (Liquids And Solids): Determining if materials are liquid or solid will also play an important part in selecting PPE. Some fabrics may not be good for liquid chemicals, but may be perfectly good to use when the chemical is contained in soil. Tyvek should not be used on liquid oil spills, but can be used to clean up soil contaminated with oil. The level of protection may vary depending on the route of exposure to a particular chemical. If there is a high potential for splash or if a chemical has a skin designation, Level A may be a more appropriate protective ensemble than Level B. If the exposure levels and other chemical properties would allow the use of the Level B ensemble, Level A or B should be selected based on site conditions. If the chemical is toxic due to skin absorption, a Level A ensemble would be required.

Fabric Thickness or Weight: The thickness or weight of a protective fabric will effect its performance. Most protective fabrics have thickness listed in mils. The higher the mil number the thicker the material. A standard plastic garbage bag is about 1 mil. A thicker grade fabric will be more resistant to chemicals than a thinner fabric of the same type. A thicker fabric will also decrease worker agility to a greater degree than a thinner fabric. This may be important in selecting gloves when a great amount of manual dexterity is required.

Maintenance Requirements and Problems: Maintenance requirements will vary on different types of materials and garments. Zippers and pressure valves may require periodic cleaning, checks, or lubrication. If a good inspection, and maintenance program, is not a part of the overall PPE program, there may be unnecessary worker exposures, and reduced usable life of the PPE. Tears or other defects should be repaired immediately or the garment should be replaced. OSHA has established mandatory requirements for inspection and testing of fully encapsulating or Level A suits. This may be a time consuming process and require special equipment and trained technicians. Therefore, it may be more cost effective to use some sort of disposable garment.

Style: PPE comes in a variety of styles and designs. Some suits have back entry zippers. Some have side openings. The location of the zipper on a protective garment can have a significant affect on donning and doffing the suit. Some suits have replaceable boots and gloves. This is a very desirable feature since boots and gloves usually receive the most wear and contamination. It is much more cost effective to replace these parts than to totally dispose of a suit that is contaminated.

Cost: Cost is a major determining factor in PPE selection. Initial purchase costs, decontamination, repair, inspection, and maintenance costs must be considered when selecting PPE. PPE can also play a major role concerning cost to a customer requesting services of a Emergency Response Team. Many companies have lost bids because the overkill scenario was used for PPE selection. This generally occurs when the individual specifying what level of PPE is required and appropriate is not well versed concerning the criteria that may trigger a particular level of PPE. On the other hand, many companies lose money when the appropriate PPE is not specified. This may occur if specifying Level C when Level B is required.

J) Service: Availability of replacement parts and accessories must be considered. A "bargain suit" may not be a bargain if replacement parts are hard to locate, slow in arrival, or excessively priced. Does the supplier guarantee his product and service? A service contract may be one way to approach this issue.

The PPE program administrator must consider all of these items when selecting equipment or developing and monitoring the protective equipment program. This is a position of great responsibility that requires a good knowledge of field conditions, personnel, safety, health and regulatory requirements.

Session 10. Shipyard Respirator Protection

Great efforts must be taken in order to protect the workers from the adverse exposures associated with the respiratory system. Air Purifying Respirators (APR) are often the primary method of providing this protection. Respiratory protection is of primary importance since inhalation is one of the major routes of exposure to chemical toxicants. The respiratory surface of the lung is between 300 and 1,000 square feet for the average man. This lung surface is very thin and very delicate. Particles such as silica or asbestos can cause irreversible scarring. Gases or vapors entering the lungs are rapidly absorbed into the bloodstream and transported throughout the body. Respirators are a protective apparatus that provide various levels of protection and consist of a facepiece connected to an air source or and air purifying device.

Standards of Respiratory Protection (CFR 29: 1910.134) & Respirator Control Programs

Until the passing of the Occupational Safety and Health Act (OSHA) in 1970, the usage of respirators was generally advisory rather than mandatory. OSHA legislation introduced certain requirements for respirator use, testing and certification. The National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA) were given the responsibility for testing and certifying respirators. The OSHA respiratory protection standard, 29 CFR 1910.134, is the legal standard governing respirators. The various components of the regulations cover selection, use, monitoring, care and maintenance of the devices and employee training. Hazardous incident response teams must have a respirator control program, in place and operational.

Minimum Acceptable Respirator Program: Respirators should be used throughout shipyard operations when other methods of controlling respiratory exposure (i.e. engineering and administrative controls) are not possible or adequate. According to the standard, shipyards that use respirators must have the following program elements in-place:

1. Written program including operating procedures covering the use of respirators during normal operations and emergencies.
2. Selection of respirators based on the hazard.
3. Training in the selection, use and maintenance of respirators.
4. Fit testing of every worker who wears a negative pressure respirator for the make, model and size of the respirator worn.
5. Routine cleaning and disinfecting of respirators.
6. Storage to protect from contamination, heat and mechanical damage.
7. Replacement of worn parts.
8. Inspection of respirators used for emergencies, such as self-contained breathing apparatus (SCBAs), at least once a month and after each use.
9. Periodic surveillance of the work area, including exposure monitoring.
10. Program evaluation at least annually.
11. Use of NIOSH/MSHA approved respirators and cartridges.
12. Approval of a licensed physician and an annual review of the medical status for all workers who are assigned to work that requires the use of a respirator.

Written Respirator Program

Federal regulations and shipyard concerns require the development of a written respirator program. This program is designed to provide employees with the information necessary for the safe usage of respiratory protective equipment. All employees who are assigned tasks requiring the use of respirators must be trained and work according to the guidelines of the program.

According to OSHA , a written respirator program must include:

- A responsible person
- Respirator selection guidelines
- Respirator use training for all employees
- Fit testing for all respirators and users
- Proper respirator inspection and cleaning
- Proper respirator maintenance
- Proper respirator storage in a clean room
- Medical examination for respirator users
- Air surveillance of the work area to assure that respirators selected are adequate

A **Program Administrator** is responsible for maintaining the respirator program. Any questions concerning the program should be addressed to him/her.

Proper Respirator Selection requires that only NIOSH approved respirators are used. Respirators are always selected based on known or expected exposures. The respirator program administrator will select the appropriate respirator for each job or potential exposure.

Respirators will be selected based on the characterization of each specific task requiring respiratory protection as follows:

- Limitations of negative pressure respirators will be considered
- Identification and concentration of chemicals and warning properties
- Cartridge selection and breakthrough time
- Use of air supplied respirators when appropriate
- IDLH atmospheres

Employees will be given respirators that provide acceptable fit and protection. Any questions concerning respirator selection should be addressed to the program administrator.

Thorough Training of Employees in proper use and maintenance of the required respiratory protective equipment will be completed prior to assigning tasks requiring respirator use. Follow-up respiratory protective equipment training and fit testing will be conducted on an annual basis, as required by OSHA. Respirator training will be documented in the employees personnel file.

Fit Testing will be conducted for the specific type of respirator being used. This fit testing will include wearing the respirator in a test atmosphere such as irritant smoke or isoamyl acetate (banana oil). Additionally, the employee will be responsible for conducting a positive or negative pressure fit test each time the respirator is donned. Fit tests using test atmospheres will be repeated at least every six (6) months or if conditions affecting respirator fit occur (weight gain or loss greater than 20 pounds, facial scarring, etc.).

IDLH Atmospheres will not be entered without a safety watch, safety lines and a supplied air respirator. The safety watch must have adequate protective equipment to carry out potential rescue efforts. The safety watch must maintain audible or visual contact with personnel in the IDLH atmosphere at all times. Also, the "buddy system" will be used if employees are working in potential IDLH atmospheres.

A **Medical Monitoring Program** requires that anyone assigned a task requiring use of respirators be examined by a physician and certified as being able to safely wear the respirator within the prescribed scope of work. Respirators place a strain on the wearer's cardiovascular system. Some people are also claustrophobic and cannot wear respirators. Workers who have respiratory problems such as asthma or emphysema are usually poor candidates for wearing respirators. A worker's physical condition should be reviewed by a doctor before he/she is assigned to work requiring respiratory protection. The doctor should be informed of the type of work and respirators to be used. The doctor should provide a written notice stating any physical limitations.

Work Area Air Surveillance monitoring will help ensure that all the respiratory protection equipment is adequate on a continuous basis. If work conditions change in such a way that the work atmosphere may exceed the protection factors of the respirators currently in use, additional atmospheric testing will be conducted. The respiratory protection will be upgraded, as necessary.

Respirator Types

Respirators can be divided into major categories that include:

- Air Purifying Respirators (APRs), and
- Supplied Air Respirators (SARs)

Air Purifying Respirators (APRs)

Air Purifying respirators remove or filter out contaminants from the breathing air before the air is inhaled. APRs are also referred to as negative pressure respirators. APRs are capable of removing particulate matter such as dusts, mists, fumes, gases and vapors, or combinations of both. APR filters can be classified as two general groups:

1. Particle Removing Filters
2. Gas/Vapor Removing Cartridges and Canisters

1. Particle Removing Filter Respirators

These respirators are generally called dust, mist, or fume respirators and work by mechanical filtering action. The term fume is generally misunderstood. When referring to respirators or industrial hygiene sampling, fumes are very small particles. Fumes are caused when gases solidify. Welding or cutting produces various metal fumes. The metal vaporizes and quickly recondenses into a small particles that are generally less than 1 micron in diameter.

Airborne particles become trapped in the filter before they are inhaled into the worker's respiratory system. Particle removing respirators are required when workers are exposed to significant concentrations of particles that are small enough to enter the respiratory system and lungs. There are two basic types of particulate removing respirator filters. First, there is the Dust, Fume, Mist Filters" which are designed to remove particles down to 0.6 microns in size. They are constructed of fabric and are placed on the outside of the filter holder. Dust, mist and fume filters are used when the particles are not extremely toxic and have a TLV, TWA, or PEL greater than 0.05 Mg/M3. The second type of particle filter is the HEPA" (High Efficiency Particle/Aerosol) filters, which are 99.97% effective against particles of 0.3 microns. These filters will remove particles twice as small as the "dust, mist and fume" filters. HEPA filters are used for very toxic particles such as asbestos fibers. HEPA filters are required when the particle has a TLV of 0.05 Mg/M3 or less. The following chart illustrates particle deposition in the respiratory system:

Particle Size (Microns)	Health Problems
Over 15	Trapped in the nose
5 to 10	Upper respiratory tract
0. 5 to 5	Deep lung area
Under 0.5	Deep lung area or potentially exhaled (if too light to settle)

2. Gas/Vapor Filter Canisters and Cartridge Respirators

This type of air purifying respirator (APR) cartridges and canisters remove gases and vapors. These cartridges or canisters are filled with sorbents to remove the gas or vapor from the breathing atmosphere. Gas/Vapor cartridges and canisters work by absorption, adsorption or chemisorption. The following chart illustrates the cartridges color codes, types of gases controlled, sorbent material and associated information.

Contaminant	Sorbent	Cartridge Color	Miscellaneous
Organic Vapors	Activated Charcoal	Black	Cartridge limited to 1,000 ppm - Canister to IDLH Atmosphere
Acid Gases	KOH, NaOH, lime or caustic silicates	White	Varies depending on acid gas in question 10 ppm Chlorine, 50 ppm Sulfur Dioxide, 30 ppm Formaldehyde
OV / Acid Gas	Combination of both	Yellow	Same Limitations as the above
Mercury Vapor	Charcoal w/iodine	Orange	Color change end of service indicator
Ammonia / Amines	Charcoal w/metal salts	Green	Limited to 300 ppm, Ammonia 100 ppm, Methyl Amine
Particulate Cartridges:			
Dust, Fumes, Mist	Filters to 0.6 ug	Gray	Particulates with TLVs > 0.05 mg/m3
HEPA	Filters to 0.3 ug	Magenta	For particulates with TLV's < 0.05mg/m3

Respirator Cartridges Versus Canisters: Both cartridges and canisters are used with air purifying respirators to remove gases and vapors. Canisters generally have a larger capacity than cartridges and may provide more protection in highly contaminated environments. For example, organic vapor cartridges are approved for solvent concentrations *below* 1,000 ppm, whereas the largest organic vapor canisters are approved for use up to 20,000 ppm. Canisters may be equipped with a service life color indicator. Many filter cartridges do reserve a space to record the date and time when a cartridge is placed into service.

OSHA requires that cartridges and canisters are color-coded to identify the contaminants and classes of contaminants they are designed to protect against. *Do not depend on memorizing the color coding.* **ALWAYS READ THE LABEL!**

OSHA Identification System For Respirator Canister and Cartridges

Atmospheric Contaminants to Be Protected Against	Colors Assigned
Acid gases	White
Hydrocyanic acid gas	White with 1/2-inch green stripe
Chlorine gas	White with 1/2-inch yellow stripe
Organic vapor ammonia gas	Black Green
Acid gases and ammonia gas	Green with 1/2-inch white stripe
Carbon monoxide	Blue
Acid gases and organic vapors hydrocyanic acid gas and chloropicrin vapor	Yellow with 1/2-inch blue stripe
Acid gases, organic vapors and ammonia gases	Brown

Radioactive materials, excepting tritium and noble gases	Purple (Magenta)
Particulate (dusts, fumes, mists, fogs or smokes) in combination with any of the above gases or vapors	Canister color for contaminant, as designated above, with 1/2-inch gray stripe
All of the above atmospheric contaminants	Red with 1/2-inch gray stripe

NOTE- Orange is used as a complete body or stripe color to represent gases not included in this table. The user will need to refer to the canister label to determine the degree of protection the canister will afford.

Replacement of Cartridges and Canisters: Replace cartridges daily or after each use and replace canisters as recommended by the manufacturer. Be aware that organic vapor cartridges and canister work differently for each type of solvent vapor. Some solvents vapors may penetrate the cartridge or canisters very quickly and others take more time. The actual frequency of replacement will largely depend on the following:

- The chemical and its concentration
- The amount of time that the cartridges were sitting on the shelf
- The breathing rate of the person who uses them

Negative and Positive Pressure Respirators

Negative pressure respirators operate by drawing air into the facepiece by the negative pressure created by the user upon inhalation. The main disadvantage of negative pressure respirators is that if a leak develops, the user can draw contaminated air into the respirator facepiece. Negative pressure APRs are available in a variety of types including:

- **Disposable:** Disposable masks are not allowed for very toxic materials (TLV <0.05 Mg/M3). Disposable respirators are no longer allowed for asbestos work.
- **1/4 Face and 1/2 Face:** These respirators offer respiratory protection from certain chemicals, but they do not provide eye protection.
- **Full-face Cartridge and Full-Face Gas Mask:** Full-face respirators are required if the contaminant causes eye irritation and if concentrations exceed the protection factors supplied by 1/4 and 1/2 face respirators.

Positive pressure APR provide a higher level of protection than negative pressure APRs. These respirators maintain positive pressure inside the respirator facepiece by using a battery operated blower. They are used extensively in the Asbestos Abatement Industry and are mandated by OSHA regulations for some applications. These respirators have a blower to pass contaminated air through a filter, cartridge, or canister. The facepieces can be a half-mask, full-face mask, hood, or helmet.

12 Criteria for Using Air Purification Respirators

Air purification respirators present many problems when used for emergency response. There are many limitations to the use of air purifying respirators. Response personnel must consider the following 12 criteria prior to using air purifying respirators:

1. APRs do not supply oxygen and cannot be used in atmospheres that are oxygen deficient (<19.5% oxygen).
2. When vapors or gases have poor warning properties, APRs cannot be used for protection. The user must be able to detect gases or vapors by odor, taste, or irritation before the TLV. When personnel begin to smell the material it is a sign that the respirator is becoming saturated and is no longer working. If the odor threshold of a material is above the TLV personnel can be exposed to the material and not be aware of it.

3. When atmospheres are Immediately Dangerous to Life or Health (IDLH), APRs cannot be used. OSHA defines IDLH atmospheres as "an atmospheric concentration of any toxic, corrosive, or asphyxiant substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere."
4. The identity of the contaminant(s) must be known. There are several types of air purification respirators based on specific type of contaminant. Some air purifying respirators are designed for use with multiple contaminants. However, air purifying respirators should not be used if there is potential of unidentified contaminants.
5. The concentration of the contaminant(s) must be known. Each sorbent has a finite capacity for, removing contaminants. Once the sorbent reaches its saturation point it allows the contaminant to pass through. The rate at which this will occur is dependent upon the breathing rate of wearer, contaminant concentrations present and cartridge efficiency (ability to remove contaminants).
6. APRs used with filter cartridges do not provide protection from all chemicals. Cartridges are designed to provide protection for specific substances. No one cartridge provides protection for all types gases or vapors. Some chemicals are not absorbed or removed by filter cartridges.
7. Particle removing APRs become clogged (load up) and become difficult to breath through. Cartridges should be changed when breathing becomes difficult.
8. APRs used for filtering gases or vapors become saturated with the contaminant and breakthrough occurs. These filters should be changed when the contaminant is detected inside the facepiece by odor, taste or irritation.
9. APRs that operate using a negative pressure system and this increases the chance for leakage around the face to facepiece seal.
10. and 1/2 face APRs cannot be used when the concentration of gases or vapors exceeds the PEL/TWA divided by the protection factor.
11. The work area must be continuously monitored.
12. High humidity and differences in temperature reduces the service life of the respirator.

Advantages and Disadvantages of APRs:

ADVANTAGES OF APRs	DISADVANTAGES OF APRs
• Small and lightweight	• Cannot be used in oxygen deficient atmospheres.
• Do not affect mobility	• Cartridges are not available for all air contaminants.
• They can protect the lungs from toxic exposures if used properly	• Certain cartridges, canisters or filters inhibit air flow and can cause breathing difficulty.
• Some are disposable	• Hot and uncomfortable.
	• Often fit poorly, allowing you to breathe in toxic substances
	• Do not prevent skin exposure.
	• Require careful maintenance and proper storage.

Supplied Air Respirators (SAR)

Supplied air respirators (SARs) are the second category of respirators. As previously described, air purifying respirators (APRs) have limitations that prevents their use in some areas. SARs make up for the inadequacies of APRs by providing breathing air to the user from a source other than the surrounding atmosphere. SARs are more complex respirators and are available in a variety of configurations. These styles can be broken down into airline SARs and self contained breathing apparatus (SCBA).

Airline SARs

Incidents involving hazardous materials or rescues often require a longer air supply than can be obtained from standard SCBA tank (30 to 60 minutes). Airline SARs supply the worker with fresh air under pressure through an airline from an outside source such as a compressed air cylinder or air compressor. This enables the wearer to travel up to 300 feet from the regulated air supply source. This type of respiratory protection enables the responder to work for several hours without the encumbrance of a backpack with tank.

Any airline respirator that is used in a hazardous atmosphere must provide enough breathing air for the wearer to escape in the event the airline is severed. This requirement is usually accomplished by attaching the very small breathing cylinders, rated for 5 minutes, to the airline unit. Almost all airline units used in rescue situations will require the 5-minute escape cylinder. The 5-minute escape cylinders must not be disconnected from the air supply line for untethered work. Escape bottles are for escape only. To perform untethered work, a 30 or 60 minute SCBA tank can frequently be used with the airline respirator. Airline SAR have many advantages, disadvantages and operational characteristics as listed below:

- SARs can be used for protection against all particles and/or gases and can be used in oxygen deficient atmospheres.
- Airline SARs can be used for extended periods limited only by the size of the air supply, the length of the hose and the responders physical capabilities.
- SARs are sometimes cooler than APRs due to the continual supply of cool air.
- Airline SARs are lighter than SCBA units.
- Airline SARs without escape bottles cannot be used in IDLH atmospheres. The air source may be interrupted by the failure of equipment or the hose would be cut off by heavy equipment used during a hazardous materials response operations.
- Airline SARs must not exceed 125 psi at the point of attachment to the air source.
- Airline SARs must furnish the following minimum and maximum air flows:

Tight-Fitting Facepiece	115 lpm to 425 lpm
Lose-Fitting Helmet/Hood	170 lpm to 425 lpm

- The airline must maintain these flow rates at all hose lengths and air source pressures.
- Quick disconnect fittings are not allowed for connecting additional lengths of airline. Quick disconnects are allowable only at the point where the airline attaches to the air source and at the attachment point to the wearer's regulator or respirator. Quick disconnects are not to be placed between the air source and the user's regulator. The length of airline hoses cannot exceed 90 meters or 300 feet.
- Airline SARs require continual monitoring and maintenance to supply the required pressure/air flow. Increasing hose lengths or the number of users on the system requires adjustment of the entire system.
- SARs without emergency escape bottles or without positive pressure operation are not allowed for IDLH atmospheres.

Airline SARs are also referred to as type C or CE respirators. Type C respirators are SARs with the air supplied to a hood, helmet, facepiece, or complete suit. Type CE respirators supply additional protection from rebounding abrasive material (shipyard abrasive blasting respirators).

Self Contained Breathing Apparatus (SCBA)

SCBAs supply fresh air from a tank carried by the wearer. This eliminates the need for an airline, escape bottle and a stationary air source. SCBA provides the wearer greater mobility then the airline SAR at the cost of weight and working time. SCBAs are available in two different designs that include: 1. Closed circuit SCBAs (Re-breathers) and 2. Open circuit SCBAs.

1. **Closed Circuit SCBA:** Closed circuit SCBAs recycle the exhaled air through a series of filters to remove excessive water vapor and carbon dioxide. These respirators replenish the oxygen from a small cylinder of compressed oxygen or by a chemical reaction that releases oxygen from the water vapor in the exhaled air. Closed circuit SCBAs offer longer use times than open circuit SCBAs by filtering (cleaning) and reusing the air supply. A closed circuit respirator manufactured and rated to deliver 60 minutes of air does provide 60 minutes for emergency response.

2. **Open Circuit SCBA:** Open circuit SCBAs draw air from a compressed air cylinder tank. The cylinder is under pressure from 2,250 to 4,500 psi. The air is delivered to a regulator that steps down the pressure to 125 psi, which is then drawn into the facepiece by the user. These respirators are manufactured to deliver 30 or 60 minutes of air to the user. The delivery time available is highly dependent on the users physical condition and breathing rate. Usually a 30 minute bottle will not supply more than 15 minutes of air and sometimes even less. Closed circuit SCBAs are manufactured with the two following different operating modes:

    Pressure Demand: Pressure demand respirators deliver air to the facepiece when the user inhales. The main disadvantage of this apparatus is that if the face-to-facepiece seal is broken the user can draw contaminated air from the atmosphere.

    Positive Pressure: Positive pressure respirators continuously deliver air to the respirator facepiece whether or not the user is inhaling. The main advantage of the apparatus over the pressure demand type is that if the face-to-facepiece seal is broken the positive pressure causes air to leave the facepiece and the user cannot breath contaminated air from the atmosphere.

There are four basic components to SCBA:

- The backpack and harness assembly
- The air cylinder assembly - includes cylinder, valve and pressure gauge
- The regulator assembly - includes high-pressure hose and low-pressure alarm
- Facepiece assembly - includes low-pressure hose (breathing tube), exhalation valve (for SCBA with harness-mounted regulator) and head harness

Backpack and Harness Assembly: The backpack assembly is designed to hold the air cylinder on as comfortably and secure as possible. Adjustable harness straps provide a secure fit. The waist straps are designed to help properly distribute the weight of the cylinder and pack.

Air Cylinder Assembly: Air cylinders come in different sizes and with a variety of high-pressure hose connections. Because the cylinder must be strong enough to safely contain the compressed air, it constitutes the main weight of the breathing apparatus. When full, a 2,216 psi, 30-minute cylinder ranges from 9.6 lbs for a composite cylinder to 23.8 lbs for a steel cylinder. On the average, composite cylinders weigh about 16 lbs, while steel and aluminum cylinders weight about 20 lbs.

Regulator Assembly: Air from the cylinder travels through the high-pressure hose to the regulator. The regulator reduces the pressure of the cylinder air to slightly above atmospheric pressure and controls the flow of air to meet the respiratory requirements of the wearer. When the responder inhales, a partial vacuum is created in the regulator. The apparatus diaphragm moves inward, tilting the admission valve so that low-pressure air can flow into the facepiece, which creates the positive pressure. Exhaling moves the diaphragm back to the "closed" position. Some SCBA units have regulators that fit into the facepiece and other units have the regulator on the chest or waist strap.

On many models, two external knobs, differing in color, shape and location, control the mainline valve and the bypass valve. During normal operation, the mainline valve is fully open and locked. The bypass valve is closed. On some SCBA, the bypass valve controls a direct airline from the cylinder in the event that the regulator fails. Once the valves are set in their normal operating positions, they should not be changed unless the emergency bypass valve is needed.

A pressure gauge that shows the air pressure remaining in the cylinder is usually mounted on or near the regulator or on the high-pressure hose. The regulator pressure gauge should read within 100 psi of the cylinder gauge. If increments are shown in other measurements, such as percents or fractions, both measurements should be the same. If they are not consistent, rely on the lower reading and check the equipment for any needed repair before using it again.

All units have an audible alarm that sounds when the cylinder pressure decreases to a preset level, which is from 450 to 500 psi, depending on the manufacturer. HazMat Technicians should leave the area immediately if the alarm sounds.

Facepiece Assembly: The facepiece assembly consists of the facepiece lens, an exhalation valve and if the regulator is separate, a low-pressure hose to carry the air from the regulator to the facepiece. The facepiece lens is made of clear safety plastic and is connected to a flexible rubber mask. The facepiece is held snugly against the face by a head harness with adjustable straps, net, or some other arrangement. The lens should be protected from scratches during use and storage. Some facepieces have a speech diaphragm to make communication easier.

The low-pressure hose brings air from the regulator into the facepiece. It must be kept free of kinks and away from contact with abrasive surfaces. The hose is usually corrugated to prevent collapse when a person is working in close quarters, breathing deeply, or leaning against a hard surface. The facepiece and the hoses are constructed of common elastomers including: oil-resistant rubber, neoprene, silicone, or plastic resin.

The exhalation valve at the chin of the facepiece is a simple, one-way, valve that releases an exhaled breath, without admitting any of the contaminated outside atmosphere. Dirt or foreign materials can cause the valve to become partially opened, which may permit the contaminated outside atmosphere to enter the facepiece. Therefore, it is important that the valve be kept clean and free of foreign material. It is also important that the exhalation valve be tested by the responder during facepiece fit-tests and before entering a hazardous atmosphere.

SCBA Safe Work Practices

HazMat Technicians response personnel need to use self-contained breathing apparatus (SCBA) to provide respiratory protection at a hazardous substance incidents. Every model of SCBA is different. Response personnel must be properly trained with the specific units they have available to them.

Proper Donning of SCBA
SCBA can be donned like a coat, putting one arm at a time through the shoulder strap loops. The unit should be arranged so that either shoulder strap can be grasped for lifting.

1. Start by checking the cylinder gauge to make sure that the air cylinder is full. Open the cylinder valve slowly and listen for the audible alarm as the system pressurizes. Then, open the cylinder valve fully. If the audible alarm does not sound, or if it sounds but does not stop, place the unit out of service. Tag it so that no one else attempts to use it.
2. Have your partner lift the SCBA backpack and hold it behind you at the proper height.
3. Place your arms though the shoulder straps one at a time. Lean slightly forward to balance the cylinder on your back.
4. Tighten the shoulder straps by pulling them outward and downward. Sometimes it will be necessary to lean forward with a quick jumping motion to position the SCBA on the back.
5. Continue leaning forward while you fasten the chest buckle if the unit has chest straps. Tighten the shoulder straps further if necessary. Fasten and adjust the waist strap.
6. Recheck all straps to see that they are correctly adjusted.

The SCBA Facepiece Fit
The facepieces for most SCBA are donned in a similar fashion. However, facepieces from different units often have different features. Despite these differences, the uses and donning procedures are essentially the same. Responders should not rely solely on tightening facepiece straps to ensure proper fit. A facepiece tightened too much will be uncomfortable or may cut off circulation to the face. Each person must be fitted with a facepiece that conforms properly with the shape and size of the face. For this reason, many SCBAs are available with different sized facepieces.

Donning the Facepiece
The following procedures apply to a facepiece with a low-pressure hose:

1. Grasp the harness with your thumbs through the straps from the inside and spread the straps.
2. Push the top of the harness up your forehead to remove hair that may be present between your forehead and the sealing surface of the facepiece. Center your chin in the chin cup and position the harness so that it's centered at the rear of your head.
3. Tighten the harness straps by pulling them evenly and simultaneously to the rear. (Pulling the straps to the sides, may damage them and will prevent proper engagement with the adjusting buckles.) Tighten the lower straps first, then the temple straps and finally the top strap.
4. Check the facepiece seal. Exhale deeply, seal the end of the low-pressure hose with your bare hand and inhale slowly (not deeply). Hold your breath for 10 seconds. This action allows the facepiece to collapse tightly against your face. (Note: Inhaling very quickly will temporary seal any leak and will give a false sense of security.) If there is evidence of a leak, adjust the facepiece and test again.
5. Check to make sure the exhalation valve is functioning properly. Inhale, seal the end of the low-pressure hose with the palm of your hand and exhale. If your exhaled air escapes at the edges of the facepiece and does not go through the exhalation valve, keep the low-pressure hose sealed, press the facepiece against your face and exhale to free the valve. Use caution when exhaling against a sealed facepiece to prevent possible damage to the inner ear. If you cannot get the exhalation valve free, remove the facepiece from service and have it checked.

6. Connect the low-pressure hose to the regulator and open the mainline valve. Check for positive pressure.
7. Gently break the facepiece seal by inserting two fingers under the edge of the facepiece. You should be able to feel air moving past your fingers. If you cannot feel air movement, remove the unit and have it checked.

Doffing the SCBA

It is generally recommended that you do not remove SCBA until after you have completed the decontamination process. Leave your mask in place until you have gone all the way through decontamination and have removed any contaminated clothing. To remove the facepiece after decontamination:

1. Disconnect the low-pressure hose from the regulator, then close the mainline valve.
2. Grasp the facepiece at the chin and pull it away from your face and over your head. Loosening the straps slightly first may make it easier to remove the facepiece.
3. Unbuckle the waist and shoulder straps on the cylinder harness and loosen them enough to make it easier to remove the unit. Have your partner assist you as you pull your arms through.
4. Once you have removed the unit, close the cylinder valve and bleed down the air in the high pressure hose by slowing turning the emergency bypass valve.
5. Leave the valve open until the bell stops ringing, then secure it in the closed position.

Potential Emergency Operation Problems

Responders must know how to react properly when a problem occurs with the SCBA. There are some "fixes" you can perform during an incident when problems are minor in nature. However, these are very limited. If there is a problem with your breathing apparatus you should plan to leave the contaminated area immediately. Your partner person should exit with you. No one should be working alone in a potentially hazardous atmosphere. Be sure that a malfunctioning SCBA is placed out of service until it can be repaired.

Realize that some of the problems you may experience will require you to adjust the SCBA in some manner. Fortunately, most suits will allow you to remove your hand from the outer glove and pull your arm in through the suit to make any necessary adjustments. You should practice this so that you can do it easily if you need to.

Insufficient Air Supply and Decontamination: The SCBA is equipped with a warning bell that will activate when the unit has approximately five minutes of air remaining. Response personnel should never have to leave an Exclusion Zone because this five minute warning bell has gone off. Proper planning includes making sure that personnel have time to exit the Exclusion Zone and complete decontamination before running out of air. However, should you hear this bell go off, leave the contaminated area immediately, taking your partner with you.

If you run out of air before completing decontamination, you can remove your mask while still inside a Level A suit and breathe suit air. There is sufficient air inside the suit to support your breathing for a limited amount of time. (However, if the suit has been damaged for some reason and there's a possibility of a contaminant inside the suit, you will not want to breathe suit air. Decontamination personnel must have a back-up plan to quickly get you out of the suit and provide fresh air. If you're wearing a Level B suit with the SCBA on the outside, decontamination personnel can provide you with a fresh bottle so that you do not have to remove your mask until decontamination is complete.

Problems with the Pressure Demand Valve: If there's a problem with the pressure demand valve, open the emergency by-pass valve. Immediately leave the contaminated area, taking your partner with you. (Note: this is the *only* time you should use the emergency by-pass valve. Using the by-pass valve can over-pressurize the suit and damage your eardrums.)

Free Flow of Air Supply Problem: If the unit is free flowing you will notice air blowing into the facepiece and out of the exhalation valve. Use the cylinder valve to control air flow, turning it off and on as required to provide sufficient air supply. Immediately leave the contaminated area, taking your partner with you.

Damaged Facepiece or Breathing Tube: Immediately leave the contaminated area, taking your partner with you. Realize that if something has happened to cause damage to the facepiece or breathing tube, it may have caused damage to your suit as well. You could be accidentally exposed to a hazardous atmosphere.

Respirator Fit Protection Factors (PFs)

The level of protection that can be provided by a respirator and is indicated by the protection factor (PF). The PF is the ratio between the outside and inside concentrations is used to determine a protection factor for the respirator. For example, the protection factor for a full-face air purifying respirator is 50. This means, theoretically, that workers wearing these respirators should be protected in atmospheres containing chemicals at concentrations up to 50 times the permissible exposure limit (PEL) or time weighted average (TWA). The PF rating is a characteristic of the type of respirator itself. The higher the assigned PF, the more protection the respirator should provide. The PF is only valid if the correct cartridge/canister is used and if the respirator fits properly.

To decide whether you can use a certain respirator, you need to make sure that the amount of chemicals that might enter the respirator will be less than the PEL. This concentration is calculated by dividing the ambient air concentration (determined by air monitoring), by the PF assigned to the respirator.

(Equation) Concentration Inside Facepiece = Ambient Air Concentration / Assigned PF

This will give you the concentration of the chemical that could enter your respirator. If this concentration exceeds the PEL, you need a respirator with a higher Protection Factor.

For Example: Use the following information to determine whether or not a full facepiece APR will provide adequate respiratory protection in this situation:

- For a full face APR, assigned PF is 50
- Ambient air concentration of Methyl isocyanate is 3 ppm (according to air monitoring)
- PEL for Methyl isocyanate is 0.02 ppm
- Should you use this respirator? If not, what should you use?

NIOSH assigns protection factors to general classes of respirators. Some of the fit factors assigned are included in the following table:

Class of Respirator	Facepiece Pressure During Inhalation	Assigned Protection Factor
Quarter-mask facepiece, air purifying	-	10
Half-mask facepiece, air purifying	-	10
Full facepiece, air purifying	-	50
Powered air-purifying equipped with helmet and visor	+	25
Powered air-purifying, equipped with half-mask or full facepiece	+	50
Supplied-air, continuous-flow or pressure-demand-type, equipped with half-mask facepiece	+	1,000
Supplied-air, continuous-flow or pressure-demand-type, equipped with full facepiece	+	10,000+
Supplied-air, continuous flow helmet or hood	+	2,000
SCBA, pressure-demand-type open-circuit or positive-pressure type closed circuit equipped with full facepiece	+	10,000+

From: Cal/OSHA Communications Unit, State of California, Dept. of Industrial Relations, Respirator Protection Program: Training Outline and GISO 51.44, July 1985.

Warning Properties (How Do You Know If Your Respirator Isn t Working?)

Any respirator can fail. The smell, taste, or irritation of a chemical can be a warning that your respirator is not working. Smell, taste and irritation are called warning properties. Some chemicals have no warning properties. For example, you cannot smell, taste or feel carbon monoxide, even at fatal levels. Chemicals without warning properties will harm workers before they ever smell, taste or are irritated. Other gases and vapors have a noticeable smell or taste only at high concentrations. OSHA prohibits the use of air purifying respirators unless there is an adequate warning property below the substance PEL.

Checklist To Determine When To Wear An APR

Question	YES	NO
1. Does the air contain at least 19.5% oxygen?		
2. Are the identity and concentrations of the contaminants known so you can select the proper respirator and cartridges/canisters?		
3. Are the concentrations of all contaminants less than IDLH levels?		
4. Do the contaminants have adequate warning properties less than the PEL?		
5. Is the protection factor of the respirator adequate to keep the exposures below the PELs?		
6 Is the respirator (facepiece and cartridges) NIOSH/MSHA approved for the contaminants at the measured concentrations?		
7. Have all employees been Fit Tested for the respirator in use?		
8. Have you been trained in the proper use of their respirators, including how often to change the cartridge/canister?		

In general, if the answer to ALL of these questions is YES, wear an air purifying respirator. If the answer to ANY of these questions is NO, you *must* use a supplied air respirator with a self-maintained air supply.

Shipyard Respirator Fit Testing Programs

When using air purifying respirators, proper fit and maintenance must be assured. A highly trained person is required to oversee and administer a respirator control program. This is usually a job assigned to an Industrial Hygienist or Safety Professionals. Proper fit is essential to obtaining full protection from any respirator.

What is Fit Testing? A respirator is only as good as its ability to create a seal with your face. Fit Testing identifies how well your respirator forms a seal with your face to prevent leaks.

Why perform Fit Testing? The respirator must fit workers properly in order to protect against dangerous chemicals. OSHA requires that shipyards provide Fit Testing to make sure that the respirator fits you properly.

Which respirators should be Fit Tested?

- All respirators with negative pressure facepieces require fit testing
- OSHA does not require Fit Testing of positive pressure respirators, although it is always recommended.

Respirator Fitting Concerns

Protection from inhaled substances will only be effective when a respirator is properly fitted. For respirators to fit properly, a tight seal must be maintained between the facepiece and the wearer. This is known as the “face to facepiece seal.”

- Eyeglasses with standard temple bars cannot be worn with full face respirators because the temple bars break the facepiece seal. Each manufacturer offers special eyeglass kits (spectacle kits) to mount eyeglasses inside the respirator facepiece. Corrective lenses must be fitted by a qualified individual to provide good vision, comfort and an air-tight seal.
- OSHA does not allow contact lenses in contaminated atmospheres with respirators. Contact lenses can concentrate chemical liquids or vapors under the lens on the eye. Some contact lens materials may be permeated with toxic chemicals and cause extended eye exposure.
- Excessive weight loss or gain (>20 pounds) can affect the respirator fit and requires re-fit testing.
- Excessive scars in the area of the respirator seal can affect fit and requires re-fit testing.
- Fitting with or without dentures will affect the fit of the respirator. If new dentures are obtained, a new fit test is required.
- OSHA does not allow any type of facial hair (beards, long sideburns, mustaches, etc.) that interferes with the respirator to skin seal. NIOSH has demonstrated that even a single day's growth of beard (5 o'clock shadow) can adversely affect the respirator fit.
- Jaw misalignment from dental or other problems may cause poor respirator fit. In addition, OSHA places part of the responsibility for proper use of the respirator/SCBA on the employee.

OSHA Requires Some Form of Fit Test Every Time a Respirator is Worn

There are two major types of fit testing. The first type is the quantitative fit test, which actually calculates the protection factor of the respirator. The second type is the qualitative fit test, which uses the wearers senses to determine if the respirator is fitting properly.

Quantitative Fit Testing - Exact Measurements

A quantitative fit test uses a mechanical device or computer to detect leaks in the facepiece. Atmospheric testing equipment is used to monitor the concentration of a test aerosol or vapor. This is accomplished by putting the worker, whose respirator is being tested, inside a booth containing a measured concentration of a chemical and using a probe to continuously measure the concentration of the chemical, inside the worker's respirator. The worker must breathe normally, deeply, move the head from side-to-side and up and down and talk.

Recent technology has produced a new totally self-contained quantitative fit test machine called a "Portacount". This unit does not require a fit test chamber. It measures the atmosphere inside the facepiece and compares it to particulates in ambient air. The Portacount has been approved by OSHA as meeting their quantitative fit test requirements. OSHA requires quantitative fit testing for some contaminants at concentrations above those where a half-face negative pressure respirator would afford adequate protection. Benzene, asbestos and lead are all examples of substances that OSHA requires quantitative fit testing.

Qualitative Fit Testing

The second type of fit test procedures are referred to as qualitative. Qualitative fit tests do not give an actual protection factor number, but provide a qualitative assessment of respirator fit. Qualitative fit tests rely on the wearer of the respirator subjective response. There are several types of qualitative fit tests including:

- Positive Pressure Fit Test
- Negative Pressure Fit Test
- Taste Test Fit - Saccharin Test (For Particulate Filters)
- Atmosphere Fit Testing (Four Methods)

Positive Pressure Check

This fit test method requires the respirator wearer to cover the exhalation valve of the respirator and exhale gently. The wearer should sense a slight positive pressure build-up inside the facepiece. The wearer holds his/her breath and determines if positive pressure is maintained inside the facepiece. If positive pressure is not maintained, the respirator leaks and should be readjusted or replaced.

- Cover up the exhalation valve so that no air can get through.
- Exhale gently into the facepiece.
- The fit is considered acceptable if slight positive pressure can be built up inside the facepiece without outward leakage.
- If your respirator requires removing and replacing the exhalation valve cover in order to do a positive pressure test, use this test sparingly.

Negative Pressure Fit Test

This test is the opposite of the positive pressure fit test. The wearer covers the inhalation cartridges or canister and inhales gently. This position is held for a few seconds. If negative pressure is

maintained, the respirator fits. If negative pressure is not maintained, the respirator should be adjusted or replaced.

- Cover the opening of the canister, cartridge(s), or filter(s) with the palms of the hand so that air cannot get through.
- Inhale gently so that the facepiece collapses slightly.
- Hold your breath for about 10 seconds.
- If the facepiece remains slightly collapsed and no leakage is felt, the fit is probably acceptable.

Taste Fit Test

Some respirators such as disposable dust masks cannot be fit tested using isoamyl acetate (they don't filter organic vapors) or irritant smoke (they don't filter particles less than 0.6 microns). These respirators must be fit tested in a test atmosphere to comply with OSHA regulations. The taste fit test method was developed to meet these requirements. In this fit test the respirator wearer is exposed to a test atmosphere created by a saccharin aerosol. The wearer of the respirator breaths through his/her mouth. If a taste is noted, the respirator fails the fit test.

Atmosphere Fit Testing (Isoamyl Acetate or Irritant Smoke Respirator Fit Testing Methods)

OSHA requires that respirator wearers be properly fit tested, including wearing the respirator in a "test atmosphere". The test atmosphere is usually created inside a test booth or plastic bag. There are three atmospheres used to perform qualitative fit testing. These tests require at least one additional person to provide a non-toxic chemical. This person observes whether the worker being Fit Tested can smell, or feel.

- Odor Fit Test: - Isoamyl Acetate Test (banana oil, requires an organic vapor cartridge)
  (Can you smell it?)
- Irritation Test - Smoke Test (Stannic Chloride or titanium tetrachloride, requires a HEPA filter)
  ("Can you feel it?")

All users or potential users of pressure demand-type respiratory protection devices should be fit tested to ensure a proper face-to-facepiece seal. Isoamyl Acetate or irritant smoke should be used with one of the four methods described below. Both have specific guidelines established by OSHA.

Respirator wearers are exposed to isoamyl acetate (banana oil) as a test atmosphere. Isoamyl acetate is an organic vapor with a very low odor threshold (approximately 0.002 ppm). If the respirator leaks, the wearer can smell the banana oil and fails the fit test. The test respirator is fitted with organic vapor filters.

The smoke for the irritant test is produced from glass tubes filled with stannic chloride or titanium tetrachloride. The tubes are opened and the irritant smoke is blown into the respirator wearer's breathing zone. The smoke material reacts with water vapor to produce a weak acid fume, which can be very irritating. If the respirator leaks, the wearer coughs and fails the fit test. The acid fume is composed of very small particles (0.3 microns +). Therefore, a HEPA filter is necessary on the test respirator. OSHA has established specific guidelines for this fit test method. A selection of respirators should be tested allowing users to choose the most comfortable from those that fit satisfactorily.

During all of the testing methods, the following will be applicable:

- If the seal has a leak, the test ends and the mask is recorded as unsatisfactory.
- If the subject is uncomfortable, the test ends.
- If a half-mask is being tested, the subject should be instructed to close his/her eyes before entering.
- If the subject detects the odor or smoke during fitting, record that respirator as unsatisfactory, remove it from the subject and visually inspect the face-to-facepiece seal.
- If any doubt exists about the respirator or cartridges, test a duplicate to determine if the particular unit was faulty or if the leakage, was due to the face-to-facepiece seal.

Method No. I - Swab or Brush (Organic Vapors): The swab or brush test is used only for facepieces equipped with organic vapor cartridges. Perform the test in area with no noticeable air movement. Saturate a tissue, cloth or brush with Isoamyl Acetate. Prior to testing, expose the subject to a very low concentration of Isoamyl Acetate to ensure that he/she can detect the odor. After the subject dons the respirator, visually inspect the face-to-facepiece seal.

Method No. 2 - A round Seal (Particulate): Method No. 2 is used for respirators equipped with high-efficiency filters. Perform the test in an area with no noticeable air movement. Break both ends of an MSA ventilation smoke tube. Insert one end into the tube connected to the positive-pressure end of a two-way aspirator bulb. Cover the other end with 1 to 2-inch length of Tygon, surgical or rubber tubing. Squeeze the aspirator bulb to generate the test aerosol. After the subject dons the respirator, visually inspect the face-to-facepiece seal.

- Direct the smoke around the entire sealing surface of the respirator at a distance of 3 to 6 inches. Instruct the subject to breathe shallowly during the initial test around the surface and normally thereafter, if no leakage is detected.
- Perform the test first with subject sedentary, then with subject moving his/her head and face (i.e. talking, moving the head from side to side and up and down).

Method No. 3 - Enclosure in Plastic Bag (Organic Vapors): Method No. 3 is used for facepieces equipped with organic vapor cartridges. To conduct the test, saturate a tissue or cloth with Isoamyl Acetate and suspend it inside the top of a plastic garbage bag or Harvard hood. Prior to testing, expose the subject to a very low concentration of the Isoamyl Acetate to ensure that he/she can detect the odor. After the subject dons the respirator, visually inspect the face-to-facepiece seal.

- Instruct the subject to put his/her head into the bag or hood and breathe normally during a short sedentary period (30-60 seconds).
- If no leakage is detected, instruct the subject to perform various exercises simulating work conditions (i.e. talking, running-in-place, head movements, bending over).

Method No. 4 - Enclosure in Plastic Bag (Particulates): Method No. 4 is used for respirators equipped with high-efficiency filters. To conduct the test, break both ends of an MSA ventilation smoke tube. Insert one end into the tube connected to the positive-pressure end of a two-way aspirator bulb. Cover the other end with I to 2-inch length of Tygon, surgical or rubber tubing. Squeeze the aspirator bulb to generate the test aerosol. After the subject dons the respirator, visually inspect the face-to-facepiece seal.

- Generate smoke into the input of the Harvard hood or a hole punched in the top of the closed plastic bag until smoke can be visually detected throughout the bag or hood.

- Instruct the subject to put his/her head into the bag or hood and breathe shallowly during a short sedentary period (30-60 seconds).
- If no leakage is detected during sedentary period, instruct subject to perform various exercises simulating work conditions (i.e. talking, running-in-place, head movements, bending over) while breathing normally.

Advantages and Disadvantages of Qualitative and Quantitative Fit Testing

Advantages of Qualitative Tests	Disadvantages of Qualitative Tests
Fast	Rely only on workers opinion or response.
No complicated or expensive equipment required	Test subjects may not be able to detect the odor of banana oil. They may have decreased sensitivity to the irritant smoke, or be unable to taste saccharin.
Easily performed in the field	

Advantages of Quantitative Tests	Disadvantages of Quantitative Tests
Do not rely only on workers opinion or response.	Time-consuming. Requires that the test respirator be fitted with a test probe. The respirator user is then fitted with a special respirator, rather than the actual respirator he/she will wear.
The major advantage of quantitative fit tests is that they do not depend on any response by the wearer and provide actual "fit factors" for each respirator.	Requires expensive equipment that must be operated by trained personnel.
	Each test facepiece must be the same type as the worker would actually use at his/her workplace.

NIOSH recommends that each worker be both qualitatively and quantitatively fit tested. However, only a qualitative test is required by law due to the difficulty in performing and the controversy surrounding quantitative fit tests.

Maintenance of Respiratory Protection Equipment

Shipyards using respirators or SCBA on a routine basis should have a program for respirator care and cleaning. The purpose of the maintenance program is to ensure that all respirators or SCBA are maintained at their original effectiveness. If they are modified in any way, their protection factors may be voided and workers can become exposed. The program should be based on the types of respiratory equipment involved, working conditions and hazards involved. The program requires that each employee be responsible for making sure their respirator is cleaned before it is used by themselves or other employees. The program should include cleaning and disinfecting, inspection, repair and storage.

Cleaning, Sanitizing, Rinsing, Drying and Reassembling

The manufacturers instructions should be followed for cleaning and sanitizing all respirators. In general, any good detergent may be used, but cleaner and sanitizer solutions that clean effectively and contain a bactericide are available. An alternative is to wash the respirators in detergent, followed by a disinfecting rinse. There is a possibility of dermatitis (a skin condition) if the sanitizing solutions are not completely rinsed from the respirator. Disinfecting is not always absolutely necessary if the respirator is reused by the same worker. However, where individual issue is not practiced, disinfecting is strongly recommended. A two-minute immersion is sufficient.

To avoid damaging the rubber and plastic in the respirator facepieces, the cleaner and disinfectant temperatures should be at least 120^{o} F, but not exceed 140^{o} F. Most respirator manufacturers market their own cleaners/sanitizers as dry mixtures containing a bactericidal agent and a mild detergent. They are usually available in one-ounce packets for individual use and bulk packages for quantity use. The cleaned and disinfected respirators should be rinsed thoroughly in clean water (140^{o} F Maximum) to remove all traces of detergent, cleaner and sanitizer and disinfectant This is very important to prevent dermatitis.

The respirators must be allowed to dry by themselves in clean surrounding. They should be hung form a horizontal wire, like drying clothes. A better method is to use a commercially available, electrically heated steel storage cabinet with a built-in circulating fan. Care must always be exercised so the facepieces are not damaged.

A simple procedure for cleaning and disinfecting respirators is as follows:

- Remove all cartridges, canisters and filters, plus gaskets or seals not affixed to their seats.
- Remove elastic headbands.
- Remove exhalation cover.
- Remove speaking diaphragm or speaking diaphragm-exhalation valve assembly.
- Remove inhalation valves.
- Wash facepiece and breathing tube in a solution of cleaner/sanitizer powder mixed with warm water, preferably at 120^{o} F to 140^{o} F.
- Wash components separately from the facepiece, as necessary.
- Remove heavy soil from the surface with a hand brush.
- Remove all parts from the wash water and rinse twice in warm, clean water.
- Air dry parts in a designated clean area.
- Wipe facepieces, valves and seat with a damp, lint-free cloth to remove any remaining soap or other foreign materials.

The clean, dry respirator facepieces should be reassembled and inspected in an area separate from the disassembly area to avoid contamination. Inspect for detergent or soap residue left by inadequate rinsing. This appears most often under the seat of the exhalation valve and can cause valve leakage or sticking. New or re-tested filters, or new cartridges and canisters should be installed and the completely reassembled respirator should be tested for leaks.

Respirator Inspection

Inspections need to be performed on respirators after each use. Respirators reserved for emergency use should be inspected on a monthly basis to ensure that they will perform satisfactorily. Thoroughly check all connections on respirators to ensure that gaskets and "O" rings are in place. Check for proper tightness. Always maintain a record for each respirator inspection. Each inspection record should include: inspection date, inspector's name and any unusual conditions or findings. An inspection procedure listing is provided in the following table.

Maintenance of Respiratory Protection Equipment	
Respiratory equipment must be inspected:	• Before and after each use • During cleaning
Equipment designated for emergency use must be inspected:	• After each use • At least monthly • During Cleaning

Examine the facepiece for:	• Excessive dirt • Cracks, tears, holes or distortion from improper storage • Cracked or badly scratched lenses in full-facepieces • Incorrectly mounted full-facepiece lens or missing mounting clips • Cracked or broken air-purifying element holder(s), badly worn threads, or missing gasket(s), if required
Examine the head straps or head harness for:	• Breaks • Loss of elasticity • Broken or malfunctioning buckles and attachments • Excessively worn straps that might permit slippage
After removing the cover, examine the exhalation valve for:	• Foreign material, such as detergent residue, dust particles, or human hair under the valve seat • Cracks, tears, or distortion in the valve material • Improper insertion of the valve body in the facepiece • Cracks, breaks, or chips in the valve body, especially in the sealing surface • Missing or defective valve cover • Improper installation of the valve in the valve body
Examine the all air purifying elements for:	• Incorrect cartridge, canister, or filter for the hazard • Incorrect installation, loose connections, missing or worn gaskets, or cross-threading in the holder • Expired shelf-life date on the cartridge • Cracks or dents in the outside case of the filter cartridge • Evidence of prior use of the sorbent cartridge or canister, indicated by the absence of sealing material, foil, tape, etc., over inlet. Check manufacturers instructions for further information.

Respirator Adjustment and Repair

The OSHA standards state that replacement or repairs shall be performed by experienced persons with parts specifically designed for the respirator. Parts from a different brand or type of respirator should never be substituted. These restrictions apply primarily to maintenance of the more complicated devices, especially SCBAs and even more specifically to their reducing or admission valves (regulators). It may be necessary to send high-pressure-side components of SCBAs to an authorized facility for repairs. An important aspect of any maintenance program is having enough spare parts on hand. Pay attention to what parts are used up quickly in order to determine what parts (and how many of them) should be kept in stock. Keep a record parts usage and inventory.

Respirator Storage

Proper storage is very important to keep respirators clean and in good working order. Follow the manufacturers storage instructions which are always furnished with new respirators or affixed to the lid of the carrying case. OSHA requires that respirators be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture and damaging chemicals. Protection against mechanical damage is also very important. Never leave a respirator unprotected (for example on a workbench or in a tool cabinet or tool box where heavy tools may damage it). Do not store respirators in clothes lockers, bench drawers or tool boxes. Place them in wall compartments at work stations or in a work area designated for emergency equipment, or store them in the original cartons or carrying cases. It is strongly recommended that freshly cleaned respirators be placed in heat-sealed or reusable plastic bags until they are needed. They should be stored in a clean, dry location away from direct sunlight. They should be stored in a single layer with the facepiece and exhalation valve in a more or less normal position to prevent the rubber or plastic from taking a permanent distorted "set."

Session 11. Introduction to Air Monitoring

Air contamination is one of the most common sources of chemical exposure in the shipbuilding industry. Air contamination may occur in the basement of your house, while driving to work, at work and during emergency incidents. Operating air monitoring instruments to detect the level of air contamination can be performed by those trained in confined space entry, emergency response, industrial health and safety and advanced hazardous materials handling. Air monitors that provide reliable measurements of air contaminants are essential for determining potential exposure levels and hazardous conditions.

Monitoring instruments are used for characterizing sites and ensuring the protection of personnel working near hazardous substances and in locations with suspected air contamination. Generally, these monitoring or surveillance instruments are referred to as Direct Reading Instruments ("DRI") and provide "real-time" readings of airborne contamination. "Real-time" means the reading on a DRI is a true reading at the time the instrument is being used, assuming proper calibration and operation.

HazMat Technician Level emergency responders are required to understand correct operation of monitoring instruments and know how to interpret the results. If the HazMat Technician incorrectly uses or interprets surveying instruments, dangerous situations could be present. For example, if monitoring is performed incorrectly, inappropriate work practices can be specified (i.e., incorrect levels of personal protection may be assigned). The shipyard should train all employees with the equipment that they will be using. The following field surveying instruments will be discussed:

- Calorimetric Detector Tubes
- Electrochemical Sensors (Oxygen, Carbon Dioxide and Toxic Gas Meters)
- Combustible Gas Indicators ("CGI")
- Photoionization Detectors ("PID")
- Flamionization Detectors ("FID") or Organic Vapor Analyzer (OVA)

Shipyard Conditions to be Monitored and/or Characterized

A wide range of monitoring is needed due to the variety of operations and the extremely diverse working environments onboard ships and throughout the shipyard process areas. Some of the conditions that warrant monitoring are as follows:

- Identify airborne contaminants in a buildings, work spaces, or during an emergency incident
- Identify potentially life-threatening situations (IDLH conditions, especially in confined spaces)
- Determine what type of protective equipment and controls are needed
- Monitor compliance with health and safety (OSHA) standards.
- Oxygen deficiency or enrichment in confined spaces
- Immediate Danger to Life and Health (IDLH) concentrations of airborne contaminants
- Potential radiation hazards
- Combustible gas monitoring, which could identify explosive atmospheres
- Toxic gas monitoring in certain situations
- Air quality in confined spaces, tanks and several shipyard and shipboard locations
- Leaking drums, pipes, tanks and other containers
- New work locations and operations
- Emergency response before initial entry into exclusion zone
- Opening drums containing unknown materials, in confined areas and/or by unprotected employees

Two Types of Shipyard Air Sampling Methods

Instantaneous, or "grab," sampling: Instantaneous sampling is an excellent method for gaining information about a particular point in time and space. Usually, grab samples are extremely accurate although they are sample specific. Some of the factors outlining grab sampling are:

- They are used to obtain a quick and rough estimate of the workers breathing environment
- They require the collection of an air sample over a short period or time (approx., 1 to 5 min.)
- They are only representative of the contaminant concentration at one moment in time, which can lead to problems if it is assumed that that condition is constant.
- They must be interpreted with caution since conditions change frequently Several grab samples may be required to get a good interpretation of an area air contamination and characterization.

Integrated, or "composite," sampling: The composite sample involves the collection of a known volume of air over a longer recorded time (i.e., 8 hours). A sampling period is determined by lab analytical sensitivity or by the need to comply with standards set on the basis of a time-weighted average (TWA). Therefore, the composite sample represents the total accumulated dose over a period of sampling and is also used to determine the average exposure over the sampling time. The results will generally determine steps to be taken with respect to engineering controls, administrative adjustments and application of personal protective equipment (PPE). The two major types of integrated air monitoring techniques and their benefits are listed below:

Two types of integrated sampling	Benefits
Area or Atmospheric Sampling	• Helps determine the surrounding air concentrations in the entire work area. • Helps determine the dispersion of contaminants from the source, dilution of contaminants, boundaries of site zones and levels of protection in all site zones
Personal Sampling	• Samples taken are often in the worker's breathing zone. • Helps determine air contaminant concentration in immediate work areas. • Assesses actual inhalation exposure more accurately. • Helps identify workers or jobs with higher routine exposures.

Two Types of Monitoring Instruments

Direct Reading Instruments (DRI): Sampling and analysis are carried out within the instrument so that results can be read directly at the work-site. This provides "real time" measurement values.

Integrated Sampling Instruments: Integrated sampling instruments are used to sample air in the field. Analysis, or interpretation, is performed later in the laboratory. They are frequently used when lab analysis requires a minimum sampling period or when a comparison with an 8 hour TWA is required. There are two methods of integrated sampling instruments.

Active method: This method requires personal sampling pumps with charcoal detector tubes (for organic vapors) or filter cassettes (for particulates).

Passive method: This methods uses diffusion tubes or badges (organic vapor monitors) and TLD badges (for radiation dosimeters).

Area Air Sampling Strategies

To assess air contaminants more thoroughly, air sampling devices equipped with appropriate collection media are placed at various locations throughout the area. These samples provide air quality information for the period of time they operate and can indicate contaminant types and concentrations over the lifetime of site operations. Data is obtained from the analysis of samples (DRIs, knowledge about materials, site operations, potential for airborne toxic hazards) and adjustments are made in the type, number, frequency and analysis of samples. In addition to air samplers, area sampling stations may also include DRIs equipped with recorders and operated as continuous air monitors. Area sampling stations are located in various places including:

Area	Description
Upwind	Because many hazardous incidents occur near industries or highways that generate air pollutants, samples must be taken upwind from the site.
Support Zone	Samples must be taken near the command post or other support facilities to ensure that they are in fact located in a clean area and that the area remains clean throughout operations at the site.
Contamination Reduction Zone	Air samples should be collected along the decontamination line to ensure that decontamination personnel are properly protected and that on-site workers are not removing their protective gear in a contaminated area
Exclusion Zone	The exclusion zone presents the greatest risk of exposure to chemicals and requires the most air sampling. The location of sampling stations should be based upon hot-spots or source areas detected by DRIs, types of substances present and potential for airborne contaminants. The data from these stations, in conjunction with intermittent walk-around surveys with DRIs, are used to verify the selection of proper levels of personnel protection, set exclusion zone boundaries, as well as provide a continual record of air contaminants.
Downwind	Sampling stations are located downwind from the site to determine if any air contaminants are migrating from the site. If there are indications of airborne hazards in populated areas, additional samplers should be placed downwind.

Shipyards should set-up a system to determine the monitoring requirements for various hazardous substance release scenarios.

During shipyard emergency response situations, air monitoring must be completed in conjunction with rescue operations and potential evacuation. When implementing an air surveillance program a the following factors must be considered:

- Type of equipment and associated costs
- Personnel requirements particularly specific competencies
- Need for accuracy of analysis
- Turn-around-time to obtain analysis results
- Availability of analytical laboratories

An emergency response monitoring program achieves a reasonable balance between cost, accuracy and time in obtaining data using a combination of direct reading instruments (DRIs) and air sampling systems. The following objectives are achieved:

- Rapid survey for airborne organic vapors and gases
- Identifying and measuring organic vapors and gases
- Identifying and measuring particulates and inorganic vapors and gases

Area surveys using DRIs are conducted routinely two to four times daily. These surveys are to monitor for general ambient levels, as well as levels at sampling stations, hot-spots and other areas of site activities. As information is accumulated on airborne organics, the frequency of surveys can be adjusted.

Combustible Gas Indicators (CGI)

Combustible Gas Indicators are used to determine if a mixture of flammable gases or vapors is present in the air. Sometimes this apparatus is referred to as an explosion meter. CGIs measure combustible gases as a percent of the lower explosion level (LEL) of the calibration gas. CGIs are used when entering confined spaces and during emergency response to hazardous incidents. CGIs are manufactured to be intrinsically safe or explosion proof.

When the CGI is exposed to a test atmosphere, the gases are aspirated into the gas sample chamber. If flammable gases or vapors are present they are burned on the filament in the gas sample chamber. The burning causes a change in the electrical resistance between the two filaments and the response is indicated on the readout scale. The filaments used in CGIs are manufactured in different styles and must be calibrated accordingly.

Operating a CGI is relatively simple. There are various styles from different manufactures. The face of the instrument will include an analog or digital dial readout window to provide readings information.

Limitations - Although CGIs are very durable there are certain limitations that the operator must know. The CGI burns flammable gases and requires the three elements of the fire triangle, heat, fuel and oxygen. The follow items are very important for CGI operation:

- CGI units are generally designed to operate in atmospheres of at least 16% oxygen.
- The oxygen level must be measured prior to testing for combustible gases.
- The heat is supplied by the batteries inside the instrument and they must remain charged.
- The fuel is supplied by the atmosphere being tested. If the atmosphere is not flammable and in the form of a gas or vapor nothing will burn. Remember, dusts, mists and aerosols cannot be measured by a CGI.

Interference s - There are certain materials that degrade the meters filaments. Some materials will coat the filaments rendering them inoperable. This is called poisoning the filament. Some of the materials and their effects are described below:

- **Organic lead** can degrade the filament and render the unit inoperable. This can occur when decommissioning a gasoline tank which contained leaded gasoline. The tetraethyl lead will actually plate onto and cover the filament. Manufactures sell lead filters which prevent lead from contacting the filament.
- **Silicone** will coat the filament and prevent the unit from operating by poisoning the filament. This can occur when cleaning the unit with a silicone based cleaner. If a filament is coated with silicone it must be replaced. All cleaners should contain materials that do not effect the filament, such as CGI alcohol.
- **Liquids** such as water, or even flammable liquids, can poison the filament. This may occur when the instrument probe is submerged into liquids which are aspirated into the unit. A liquid filter or trap can be installed on the CGI in these situations.

- **Halogenated compounds,** at high concentrations, may cause damage to the filament. This kind of damage is usually reversible and can be eliminated by leaving the unit turned on for an extended period of time.

Remote Sampling - In many cases, atmospheres are tested from a remote location prior to actual entry. The instrument breaths in the test atmosphere by using a pump or squeeze bulb. However, these remote systems can develop leaks. When this occurs, the test atmosphere may be at the location of the leak as opposed to the probe location. When using remote systems, they should be tested for leaks prior to use.

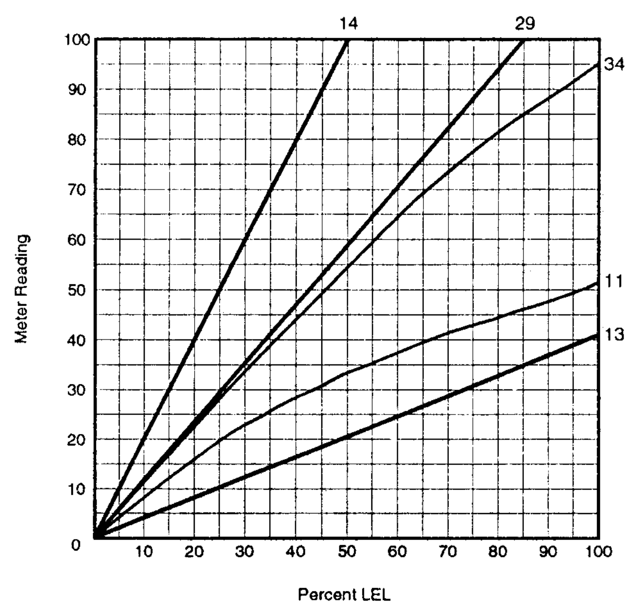
CGI Reading - HazMat Technicians who have not been adequately trained to operate a CGI are led to believe that the reading indicates the percent of combustible gases in the test atmosphere. This is not the case. The CGI measures a percentage of the LEL of the calibration gas. For example, the LEL for acetone is 2.5%. If the atmospheric concentration of acetone is 2.5%, then the percent LEL will be 100%. If the atmospheric concentration of acetone is 1.25%, then the percent LEL will be 50%.

For safe entry into an atmosphere with the potential for explosion or fire, the reading on the CGI should be <10% of the LEL. This leaves a buffer zone to allow for fluctuation of the concentration as work in the area progresses. Even though concentrations are below the LEL, at concentrations above 10% and the mixture is too lean to burn, work should not be performed and concentrations must be reduced to provide a safe working environment.

Readings - When concentrations of flammable gases is at the Upper Explosion Limit (UEL) CGIs will react differently. Analog meters may deflect to 100% and then back to zero. Digital meters may continue to reach numbers above 100 % such as 200 %, 250% and 300% etc.

It is highly recommended that flammable atmospheres be reduced to <10% LEL concentration or made inert. In some cases, if the concentration of flammable gases is above the UEL, some HazMat workers will work in that atmosphere because the mixture is to rich to burn. This is not a good practice due to the fact that as work progresses the concentration may be reduced to within the explosive range.

Manufactures provide response curves because meters will respond differently to certain gases. An example of response curves are provided below and illustrate how to determine the percent of the LEL for gases which are different than the calibration gases.



For example, when using the response curve illustrated and the meter reading for carbon monoxide is at 100% LEL, the actual concentration is at 50% of the LEL. On the other hand, when the meter reading for butyl alcohol is 50% of the LEL, the actual concentration is 85 % of the LEL. At low concentrations such as 10% of the LEL there is a very small difference in the concentration. This is

one of the main reasons OSHA specifies that the % LEL must be reduced to 10% or less for entering confined spaces. CGI operators must be familiar with this concept and apply it as appropriate based on the response curves provided by the CGI manufacturer.

Summary Of CGI Operation

1. CGIs measure a percent of the LEL and not the actual concentration of the flammable gas.
2. CGIs only measure gases or vapors and not aerosols, dusts or mists.
3. Filaments may be destroyed or poisoned by leaded gasoline, silicone, liquids and halogens.
4. Batteries must be adequately charged for proper operation.
5. Oxygen concentrations must be measured when testing for combustible gases.
6. Oxygen concentration must be at least 16%.
7. Leaks may develop when using remote sampling systems.
8. Response may be different from gas to gas and response curves must be consulted.
9. When concentrations are above the UEL erroneous readings may be indicated.
10. CGIs must be calibrated regularly to ensure proper operation.

Photoionization detectors (PID)

Photoionization detectors use high-energy ultraviolet (UV) light to displace electrons from contaminants in the air. The ions created by this photoionization are trapped in a chamber and allowed to migrate to a charged end. This ionization is measured as electrical current and is displayed on the meter. The energy required to ionize a compound is the ionization potential (IP) of the compound. The IP is measured in electron volts (eV). Each compound has a unique IP. There are a variety of UV lamps available with different eV capacities. The most commonly encountered lamps have IP capacities of 10.2 or 10.6 eV. In order to be detected, a contaminant must have an ionization potential less than the eV capacity of the UV lamp. The ionization potentials of common gases are found in the *NIOSH Pocket Guide to Chemical Hazards.*

PIDs were initially designed to detect relatively low concentrations of contaminants (a few ppm to several hundred ppm). They are particularly well suited for the detection of benzene, toluene, xylene and vinyl chloride at low concentrations.

Interference s and Contamination: In the presence of high concentrations of contamination, only a small percentage of the compounds present in the sample atmosphere can be ionized and a false low reading will be produced. In addition, the presence of water vapor (humidity) or non-ionizing gases decreases the efficiency of PIDs and causes false low responses. Charged particles found in diesel exhaust, smoke and soil may also affect meter readings.

The lamp and ionization chamber are also affected when high concentrations of gas condense inside the instrument. This can occur when the temperature of the incoming gas or vapor is warmer than the instrument temperature and is similar to the condensation on a bathroom mirror after a hot shower. The only way to prevent this condensation when sampling hot vapors and gases is to allow time for the material to cool before it enters the ionization chamber. This can be performed by increasing the length of the sample line or collecting a sample and allowing it to cool.

Interpretation of Results: Like the CGI readout, the PID readout reflects the instruments response relative to its calibration gas. When a gas or vapor other than the calibration gas is present, or when there is a mixture of gases, the meter reading does not reflect the actual concentration of gas present. Rather, the reading represents the total concentration of gases in the air that the PID can ionize. Until other tests are performed or more evidence is uncovered, it is usually safest to assume that the amount of gas present is greater than the meter reading indicates.

While PIDs can detect many materials at low ppm concentrations, they do not detect everything. Contaminants may be present even when there is no response from a PID. A PID, like any other detection device, should be used in conjunction with other instruments. No single instrument, including one as sophisticated and sensitive as a PID, should be trusted as the only source of information.

Flame Ionization Detectors (FID) A.K.A. Organic Vapor Analyzers (OVA)

Flame ionization detectors (FIDs) also use charged particles or ions to detect chemicals. FIDs use a hydrogen flame to burn organic (carbon-containing) materials in air. As they burn, the positively charged carbon-containing ions are produced and a current is generated similar to that of the PID process. The hydrogen flame has sufficient energy to ionize organic materials with ionization potentials up to 12.4 eV.

Modes of Operation: FIDs frequently operate in two different modes, gas chromatograph (GC) option and survey mode. With the GC option, individual components can be detected and measured independently, with some detection limits as low as a few parts per million (ppm). In the survey mode, it can determine approximate total concentrations of all detectable substances in atmosphere.

Methods of Use: In the GC mode, a small sample of ambient air is injected into a chromatographic column and carried through the column by a stream of hydrogen gas. Contaminants with different chemical structures are retained on the column for different lengths of time. These are called retention times and are detected separately by the flame ionization detector. A strip chart recorder can be used to record the retention times, which are then compared to the retention times of a standard with known chemical constituents.

Like PIDs, FIDs display meter readings relative to the calibration gas. FIDs do not bum, or ionize, all organic materials with the same efficiency. The FID meter reading, therefore, does not reflect the total concentration of carbon-containing materials in air. An FID has a more generalized response due to the nature of breaking chemical bonds with a set amount of energy. Due to variations in detecting contaminants, FID readings are always given in units of ppm.

FIDs with a GC attachment and a strip chart recorder can be used to separate and measure the relative concentrations of known contaminants in air. This requires injecting known standard concentrations of each contaminant and observing the meter response on the strip chart recorder. If unknowns are present, it is very difficult to determine their identity using an FIDs.

Use Considerations: The most useful FID for emergency response is a meter operating in the survey diode mode, the meter continually draws in sample air and gives a reading in response to the level of contamination present. There are survey mode FIDs available that can read 0 to 1,000 ppm or 1,000 to 10,000 ppm.

FID models are available with Class 1 Groups ABCD approvals. Intrinsically safe FIDs are equipped with flash arrestors wide are safe flammable atmospheres. As an added safeguard, the FID is designed so that tile supply hydrogen is temporarily interrupted when flammable vapors increase the height of the hydrogen flame. This interruption extinguishes the flame. **FIDs that are not intrinsically safe must not be used for hazardous materials emergency response**.

Comparing Photoionizing Detector (PID) and Organic Vapor Analyzer (OVA)

The Photoionizing Detector (PID) and the Organic Vapor Analyzer (OVA) are used in the field to detect a variety of compounds in air. The two instruments differ in their modes of operation and in the number and types of compounds they detect. Both instruments can be used to detect leaks of volatile substances from drums and tanks, determine the presence of volatile compounds in soil and water, make ambient air surveys and collect continuous air monitoring data. If personnel are thoroughly trained to operate the instruments and to interpret the data, these instruments can be valuable tools for helping to decide the proper levels of protection, assist in determining other safety procedures and determine subsequent monitoring or sampling locations.

The OVA has an inherent limitation in that it can detect only organic molecules. Also, it should not be used at temperatures lower than about 40^{o}F because gases condense in the pump and column. It has no column temperature control, although temperature control kits are available. Despite these limitations, the GC mode, can often provide tentative information on the identity of contaminants in air without relying on costly, time consuming laboratory analysis.

The PID is easier to use than the OVA. Its lower detection limit is also in the low ppm range. The response time is rapid. The meter needle reaches 90% of the indicated concentration in 3 seconds for benzene. It can be zeroed in a contaminated atmosphere and does not detect methane.

Other Considerations: Both of these instruments can monitor only certain vapors and gases in air. Many nonvolatile liquids, toxic solids, particulates and other toxic gases and vapors cannot be detected. The types of compounds that the PID and OVA can potentially detect are only a fraction of the chemicals that may be present at an incident. A zero reading on either instrument does not necessarily signify the absence of air contaminants.

The instruments are non-specific and their response to different compounds is relative to the calibration setting. Instrument readings may be higher or lower than the true concentration. When monitoring for total contaminant concentrations, if several different compounds are being detected at once this can be a very serious problem. In addition, the response of these instruments is not linear over the entire detection range. Therefore, care must, be taken when interpreting the data. All identifications should be reported as tentative until they can be confirmed by a more precise analysis.

Since the OVA and PID are small, portable instruments, they cannot be expected to yield results as accurate as laboratory instruments. They were originally designed for specific industrial applications. They are relatively easy to use and interpret when detecting total concentrations of individually known contaminants in air, but interpretation becomes extremely difficult when trying to quantify the components of a mixture. ***Neither instrument can be used as an indicator for combustible gases or oxygen deficiency.***

Comparison of OVA and PID

	OVA / FID	PID
Response	Responds to many organic gases and vapors.	Responds to many organic and some inorganic gases and vapors.
Application	In survey mode, measures total concentration of detectable gases and vapors. In GC mode, identifies and measures specific compounds.	In survey mode, measures total concentration of detectable gases and vapors.
Detector	Flame ionization detector (FID)	Photoionization detector (PID)
Limitations	Does not respond to inorganic gases and vapors. Kit available for temperature control.	Does not respond to methane. Does not detect a compound if probe has a lower

		energy than compounds ionization potential.
Calibration Gas	Methane	Isobutylene or (factory) benzene
Calibration	The instrument is factory calibrated to methane. The calibration should be checked before and after use with a calibration check gas as recommended by the manufacturer.	The calibration should be checked before and after use with a calibration check gas as recommended by the manufacturer. This should be performed to make sure that readings are accurate and consistent. Once calibrated the span setting can be changed. PID systems supply isobutylene as a check gas for the instrument.
Ease of Operation	Requires experience to interpret correctly, especially in GC mode.	Fairly easy to use and interpret.
Readout	Requires experience to interpret correctly. Depending on the make and model of the instrument, the meter can usually be read on the following ranges: 0 to 10; 0 to 100; 0 to 1000 ppm & 1 to 10,000 ppm	The PID is fairly easy to read and interpret. The meter usually can be read on the following ranges depending on the make of the instrument (0-20, 0-200 and 0-2000 ppm).
Detection Limits	0.1 ppm (methane)	0.1 ppm (benzene)
Response Time	2-3 seconds (survey mode) for CH4	3 seconds for 90% of total concentration of benzene.
Maintenance	Periodically clean and inspect particle filters, valve rings and burner chamber. Check calibration and pumping system for leaks. Recharge batteries after each use.	Clean UV lamp frequently. Check calibration regularly. Recharge batteries after each use.
Useful Range	0-1000 ppm	0-2000 ppm
Service Life	8 hours; 3 hours with strip chart recorder.	10 hours; 5 hours with strip chart recorder.

Colorimetric Detector Tubes

Detector tubes are sealed glass tubes containing mixtures of chemicals that change color when they come in contact with specific air contaminants. Different devices such as piston and bellows pumps are used to draw air samples through the tube. Detector tubes are designed to identify specific chemicals. This system is economic and is probably the cheapest system to purchase.

Different tubes are used to detect certain contaminants (qualitative indicators), or how much of a known contaminant is present (quantitative indicators). Each box of tubes comes with instructions that describe how to interpret tube responses. Indicators of chemical concentrations include a specific color change (i.e., from white to blue), change in color intensity (such as from pink to red), or the length of color change in the tube (i.e., from 0 to 4 inches down the tube). Detector tubes are marked with a scale, usually in ppm or percent. When used to detect the chemical the tube is designed to react with, a stain will appear on the tube which is then compared to the concentration scale marked on the glass tube.

To use a detector tube, select the tube appropriate for the pump and the suspected contaminant. Break off the ends of the tube and insert the tube into the pump. The manufacturer's instructions should specify the number of pump strokes necessary for the tube chosen. Many tubes have the required number of strokes printed on the tube.

Detector tubes can be purchased for measuring several hundred compounds from acetone to xylene. Multiple test (Polytest) detector tubes are also available to indicate whether or not air contamination is present. However, they do not identify contaminants by name or the concentration. Some polytest tubes are designed to produce multiple colored rings if more than one class of chemicals is present. One polytest tube, the Sensidyne Polytech IV Rainbow Detector Tube, is designed to react with 8 different contaminants: ammonia, hydrogen chloride, hydrogen sulfide, chlorine, sulfur dioxide, nitrogen dioxide, carbon monoxide and carbon dioxide.

Although a tube may be calibrated for detecting a particular contaminant, it may also react to other contaminants in predictable ways. The manufacturer's instruction sheet will often list such cross sensitivities and indicate the color changes that may occur. For example, the hydrogen chloride (HCl) detector tube is designed to discolor from blue to yellow and will also indicate nitric acid, hydrogen bromide, formic acid, acetic acid and propionic acid. The presence of oxidizing substances, such as chlorine, will produce a blue-gray discoloration.

Teaching workers to use detector tube systems is easy. They are well suited for field use unlike other DRIs such as Flame Ionizing Detectors. Each tube system is sold with instructions for the use of that particular tube box. Once a box of detector tubes are used the instructions must be discarded and cannot be used for another box of tubes even for the same substance. This is due to the fact that each set of instructions can only be used for the box of tubes for which the directions are furnished.

Pump Strokes: The number of pump strokes determines the volume of air which is pulled through the tube. Some tube detectors require only one pump stroke, while other tubes may require a number of pump strokes. All pump operators must read the instructions which are provided by the manufacturer with each box of tubes, in order to determine the proper number of pump strokes and understand which type of measurement scales is being used. Tubes requiring a number of pump strokes will be able to detect contaminants at a lower level. The greater the number of pump strokes required, the lower the detection capability of the tube. Tubes designed to measure down to 1 ppm will generally require several pump strokes.

Interference s: Detector tubes, in some cases, can react with more than one substance. When this occurs one tube can be used to measure more than one substance. However, it prevents the tube from supplying accurate information about a specific compound when the atmosphere contains more than one substance. For example, acetone and methyl ethyl ketone are both ketones. If both substances are present, the detector tube will measure the total sum of both substances. Therefore, if the concentration of acetone is 100 ppm and the concentration of methyl ethyl ketone is 75 ppm the tube will indicate the total concentration of 175 ppm, but will not distinguish between the two substances.

Ranges of Measurement: To measure a single compound, there may be several tubes available. These tubes are designed to measure a specific substance within different ranges. For example, there are two different tubes to measure formaldehyde. To detect ranges from 2 to 20 ppm a twin tube apparatus is used. To detect 0.2 to 5 ppm a single detector tube is used.

Remote Sampling: Remote kits can be obtained from manufacturers to perform remote sampling. A tube is attached to the sampling pump and the detector tube is inserted at the free end of the hose. The dimension of the tube holder permits a gas tight fitting. Being that the detector is located at the sampling end of the hose, there is no need to allow for the volume of air in the hose.

Electrochemical Sensors:
(Oxygen Meters and Carbon Monoxide and Hydrogen Sulfide Toxic Gas Meters)

Electrochemical sensors can measure oxygen, carbon monoxide, hydrogen sulfide and other contaminants in air. Electrochemical sensors contain electrolyte solutions that conduct electricity supplied from a battery. A chemical reaction occurs within the cell in the presence of particular gases, producing a small change in current. The change in current is amplified and displayed as a meter reading. Oxygen and other toxic gas meters are an essential part of the equipment used by

HazMat workers. Operation of these meters is relatively simple. These meters are frequently used in conjunction with CGIs when measuring flammable atmospheres.

Oxygen (O_2), carbon monoxide (CO) and hydrogen sulfide (H_2S) atmospheric monitoring tests are specifically required by OSHA for confined spaces. This part of the OSHA requirement has created a whole new group of meters, called "Quads", which will simultaneously monitor for LEL, oxygen, hydrogen sulfide and carbon monoxide. Using a meter with multiple capabilities shortens the time and effort of monitoring.

Use Considerations - Electrochemical sensors are affected by humidity and temperature. In addition, electrochemical sensor readings are affected by altitude. At higher altitudes, the partial pressure of a gas decreases, so a meter reading taken at a high altitude will be lower than one taken at sea level. Significant changes in meter readings obtained when a meter calibrated at sea level is moved to increasing elevations above sea level. The following table illustrates the changes in oxygen at various altitudes:

Elevation	Oxygen Reading
Sea Level	**20.9**
500 Feet	**20.4**
1,000 Feet	**20.1**
2,000 Feet	**19.3**
4,000 Feet	**18.0**
6,000 Feet	**17.3**
8,000 Feet	**15.4**
10,000 Feet	**14.3**

Interfering gases often produce false positive responses in electrochemical sensors designed to detect carbon monoxide and hydrogen sulfide. Acetylene, propane and methyl alcohol are examples of commonly encountered gases that interfere with meter readings.

As with many DRIs certain substances will interfere with the instruments capability to provide correct information. Oxygen meters can be effected if a substance will cause the pH of the electrolytic solution to change. Acid gases will change the pH and the instrument will be poisoned. Dry ice which is used to inert flammable materials storage tanks gives off carbon dioxide. As C02 will change the pH, it will render the instrument inoperable. If this occurs the unit must be repaired or replaced.

Interpretation of Results: When the presence of a specific gas is suspected, a meter designed to detect the suspected gas should be used. For example, a carbon monoxide meter may be used to evaluate post-fire atmospheres. Hydrogen sulfide meters may be useful in confined spaces containing decomposed plant or animal matter.

Oxygen meters provide a reading in terms of percent oxygen in air. The normal concentration of oxygen in air is approximately 21%. The remaining 79% is mostly nitrogen. A decrease in oxygen of I% (for example, from 20.9% to 19.9%) indicates that 5% (I% oxygen and 4% nitrogen) of the atmosphere has been displaced. Since I% by volume represents 10,000 ppm, this 5% is equal to 50,000 parts per million of a displacing gas. An oxygen decrease of only 0.I% may indicate that as much as 5,000 ppm of a displacing gas or vapor is present. ***Therefore, any deflection on an oxygen meter, however slight, may indicate an abnormal and potentially hazardous, situation.***

Readings showing an oxygen deficiency indicate two things: an immediate hazard to personnel as a result of decreased oxygen concentrations and potential health hazards from the displacing gas. However, a normal reading (20.9%) on an oxygen meter does not eliminate the possibility of the presence of a toxic gas or other contaminants.

Oxygen Meter Limitations:

1. The sensors have a shelf life of about one year.
2. The electrolytic solution can dry out. Always remember that acid gases will change the pH rendering the unit inoperable.
3. Acid gases will change the pH and poison the sensing mechanism.
4. The electrolytic solution may freeze at cold temperatures.
5. High or low atmospheric pressure may cause the unit to provide incorrect information as the unit measures the partial pressure of oxygen and not the actual percent 02.
6. Calibration is performed at ambient atmospheric concentration which is 20.8%.

Comparison of CGI, Oxygen Meters and Colorimetric Tubes

	COMBUSTIBLE GAS INDICATOR (CGI)	OXYGEN METER	COLORIMETRIC TUBES (DRAEGER)
Hazards Monitored	Flammable vapors and gases including alcohol's, acids, aldehydes, ketones, esters, aromatics, amines, nitro compounds, high (lease) concentrations of hydrogen sulfide, hydrogen cyanide, carbon monoxide and ammonia.	Areas with potentially low oxygen levels (less than 19.5 percent).	Specific unknown vapors and gases.
Application	Determines the concentration of flammable vapors and gases. This information is used to assess the risk of explosion in a particular area.	Determines the oxygen concentration in the atmosphere. Can be used to check for asphixiants and flammable and toxic gases/vapors. Important when choosing respiratory protection. Oxygen meters may be combined with CGIs.	Determines concentrations of a specific vapor or gas in the atmosphere. Information can be used to assess and identify the hazard and establish control measures.
Detection Method	Combustion of vapor/gas on heated filament.		A hand-operated bellows pump and calorimetric tubes must be used. Color change in the tube indicates a chemical reaction due to the presence of specific chemicals.
Readout	The meter indicates 0-100 percent of LEL (lower explosive limit). When concentrations are above LEL the meter will indicate greater than 100 percent. With most CGIs the meter will return to 0 when concentrations are greater than the UEL (upper explosive limit). Instruments with audio or visual alarms can be set at whatever level needed.	The instrument reads out as percent oxygen. Most instruments read from 0 to 25 percent oxygen (normal oxygen level in the atmosphere is 19.5 percent).	The tubes normally read directly in parts per million or percent from a scale on the tube. Some tubes have scales in millimeters and require conversion factors which can be found in the manufacturer's instructions.
Calibration	Calibration of CGIs should be checked before and after use to make sure that readings are accurate and consistent. Common gases used for calibration are pentane and hexane. Actual	The instrument is easily calibrated to the surrounding oxygen in a clean atmosphere by adjusting a screw or knob. The oxygen meter should be calibrated at the same	The tubes are already calibrated when you buy them. The pump flow rate and sample volume per pump stroke must be checked regularly.

	calibration requires return to the factory or trained technicians.	temperature and pressure it will be used in.	
Caution	The CGI is not effective in environments with low oxygen levels.	The instrument is affected by temperature and pressure. Oxidizers can cause increased readings. Carbon Dioxide can reduce instrument sensitivity.	The problems that contribute to poor accuracy are: leaks in the pump, insufficient contact (analysis) time, high humidity high temperature, difficulty reading the scale, other materials interfering, improperly stored tubes, out of date tubes.

Radiation Survey Meter

None of the five senses, seeing, hearing, smelling, touching or tasting, can detect the presence of radiation. Radiation detectors include survey instruments and personal dosimeters. Both can be used to obtain direct readouts of the total amount of radioactivity. Survey instruments specifically detect alpha or beta particles, or gamma rays.

Radiation meters display readings in counts per minute (cpm) or milliroentgens per hour (mR/hr). Generally, alpha radiation is measured in cpm. Readings in cpm must be interpreted using a calibration curve which is supplied by the instrument manufacturer. Beta and gamma radiation are usually measured in mR/hr (one mR equals 1/1,000 of a roentgen). Typical background radiation readings range between 0.02 and 0.06 mR/hr. Readings in mR/hr should be interpreted by a health physicist. Good meters can detect as little as 0.01 mR/hr

The most accurate method of detecting radiation dosage is the film badge. The film badge is worn while operating in the effected zone. The badge is then sent to a radiologist, where the film is developed and a dosage is estimated. This method, though the most accurate, does not provide immediate feedback during initial scene survey.

Application: To determine the presence and level of radiation. This information can be used to establish control measures to reduce or prevent exposure.
Readout: The readout is usually in mR/hour. Instruments used to detect alpha may read in counts per minute.
Calibration: The instrument must be factory calibrated at least annually. The instrument is normally calibrated to one probe allowing direct measurement of the source.
Caution: There are many types of radiation meters. Be sure to use the one appropriate for the hazard suspected.
Use Considerations: Protection against radiation includes time, distance and shielding. These factors can be incorporated with the use of detection instruments.

Relating Total Atmospheric Vapor/Gas Concentration to Level of Protection

The objective of using total atmospheric vapor/gas concentrations for determining the appropriate Level of Protection is to provide a numerical criterion for selecting Level A, B, or C. In situations where the presence of vapors or gases is not known, HazMat Technicians required to enter that environment must be adequately protected. Total vapor/gas concentration can be used as a guide for selecting personnel protection equipment.

Although total vapor/gas concentration measurements are useful to a qualified professional for the selection of protective equipment, caution should be exercised in interpretation. An instrument does not respond with the same sensitivity to several vapor/gas contaminants as it does to a single

contaminant. Also, since total vapor/gas field instruments "see" all contaminants of unknown gases or vapors, they may be over or under-estimated. Carcinogens, particulates, highly hazardous substances, infectious wastes, or other substances that do not elicit an instrument response may be known or suspected to be present. Therefore, the protection level should not be based solely on the total vapor/gas criterion. Rather, the level should be selected, case-by-case, with special emphasis on potential exposure from the chemical and toxicological characteristics of the known or suspected material.

Total Atmospheric Vapor/Gas Concentration
The phrase "total atmospheric vapor/gas concentration" is commonly used to describe the readout, in ppm, on PIDs and FIDs. More correctly it should be called a dial reading or needle deflection. In atmospheres that contain a single vapor/gas or mixtures of vapors/gases that have not been identified, the instruments do not read the total vapors/gases present. This response, indicated by a deflection of the needle, does not indicate the true concentration.

Factors For Consideration
In utilizing total atmospheric vapor/gas concentrations as a guide for selecting a Level of Protection, the following factors should also be considered:

- The uses, limitations and operating characteristics of the monitoring instruments must be recognized and understood. Instruments do not respond identically to the same concentration of a substance or respond to all substances. Therefore, experience, knowledge and good judgment must be used to complement the data obtained with instruments.

- Other hazards may exist such as gases not detected by the PID or FID, (i.e., phosgene, cyanides, arsenic, chlorine), explosives, flammable materials, oxygen deficiency, liquid/solid particles and liquid or solid chemicals.

- Vapors/gases with a very low Threshold Limit Value (TLV) or Immediately Dangerous to Life and Health (IDLH) value could be present. Total readings on instruments, not calibrated to these substances, may not indicate unsafe conditions.

- The risk to HazMat Technicians entering an area must be weighed against the need for entering. Although this assessment is largely a value judgment, it requires a conscientious balancing of the variables involved and the risk to personnel against the need to enter an unknown environment.

- The knowledge that suspected carcinogens or substances that are extremely toxic or destructive to skin are present, or suspected to be present, (which may not be reflected in total vapor/gas concentration), requires an evaluation of factors, such as the potential for exposure, chemical characteristics of the material, limitation of instruments and other specific considerations.

- Based upon total atmospheric vapor concentrations, Level C protection may be judged adequate; however, tasks such as moving drums, opening containers and bulking of materials, which increase the probability of liquid splashes or generation of vapors, gases, or particulates, may require a higher level of protection.

Level A Protection (500 to 1,000 PPM Above Background)

Level A protection provides the highest degree of respiratory tract, skin and eye protection if the inherent limitations of the personnel protective equipment are not exceeded. The range of 500 to 1,000 parts per million (ppm) total vapors/gases concentration in air was selected based on the following criteria:

- The range is sufficiently conservative to provide a safe margin of protection if readings are low due to instrument error, calibration and sensitivity.

- This concentration was selected to fully protect the skin until the constituents can be identified and measured and substances affecting the skin excluded.

- Although Level A provides protection against air concentrations greater than 1,000 ppm it is established as a warning flag to:

  ◊ Evaluate the need to enter environments with unknown greater concentrations.
  ◊ Identify the specific chemical constituents and their associated toxic properties.
  ◊ Evaluate the calibration and/or sensitivity error associated with the instruments.
  ◊ Evaluate instrument sensitivity to wind velocity, humidity temperature, etc.

- The decision to require Level A projections should also consider the negative aspects of cumbersome equipment and the physical stress caused by heat in encapsulating suits.

Level B Protection (5 to 500 PPM Above Background)

Level B protection is the minimum Level of Protection recommended for initially entering an response site where the type, concentration and presence of airborne vapors are unknown. Level B protection provides a high degree of respiratory protection. Skin and eyes are also protected, although the neck and sides of head may be exposed. This limit has been selected as a decision point for a careful evaluation of the risks associated with higher concentrations. These factors should be considered:

- The probability that substances present are severe skin hazards
- The work to be performed and the increased probability of exposure
- The need for qualitative and quantitative identification of the specific components
- Inherent limitations of the instruments used for air monitoring
- Instrument sensitivity to winds, humidity, temperature and other factors

Level C Protection (Background Levels to 5 PPM Above Background)

Level C provides skin protection identical to Level B, but lesser protection against inhalation hazards. Concentrations in the air of unidentified vapors/gases approaching or exceeding 5 ppm would warrant upgrading respiratory protection to a SCBA. The following should be considered when prescribing Level C protection:

- A full-face, air purifying mask equipped with an organic vapor canister (or a combined organic vapor/particulate canister) provides protection against low concentrations of most common organic vapors/gases.

- There are some substances against which full-face, canister equipped masks do not protect, or substances that have very low TLVs or IDLH concentrations.

- Every effort should be made to identify the individual constituents (and the presence of particulates) contributing to the total vapor readings of a few parts per million.

- Respiratory protective equipment can then be selected accordingly. It is exceedingly difficult, however, to provide constant, real-time identification of all components, with concentrations of a few parts per million, in a vapor cloud, at a site where ambient concentrations are constantly changing.

- If highly toxic substances have been ruled out, but ambient levels of a few parts per million persist, it is unreasonable to assume only SCBA should be worn.

- The continuous use of air-purifying masks in vapor/gas concentrations of a few parts per million gives a reasonable assurance that the respiratory tract is protected, provided that the absence of highly toxic substances has been confirmed.

Instrument Sensitivity and the EPA Action Guides

Although the measurement of total vapor/gas concentrations can be a useful adjunct to professional judgment in the selection of an appropriate Level of Protection, caution should be used in the interpretation of the measuring instruments readout. The response of an instrument to a gas or vapor cloud containing two or more substances does not provide the same sensitivity as measurements involving the individual pure constituents. Hence, the instrument readout may overestimate or underestimate the concentration of an unknown composite cloud. This same type of inaccuracy could also occur in measuring a single unknown substance. The idiosyncrasies of each instrument must be considered in conjunction with the other parameters in selecting the protection equipment needed.

EPA Action Guides Useful For Monitoring

Levels of Personal Protection For Unknown Atmospheres (Measured by PID or FID)	
0-5 ppm	level C
5-500 ppm	level B
500-2000 ppm	level A

Action Guides For Lower Explosive Limits (As measured by CGI)	
0-10% LEL	continue investigation
10-25% LEL	continue with caution
>25% LEL	leave area immediately

Action Guides For Atmospheric Oxygen (As measured by Oxygen Meter)	
<19.5 %	Supplied air (SCBA) required
19.5-25 %	Continue with caution
>25 %	leave area increased fire hazard

Session 12. Medical Surveillance Programs

Hazardous materials response personnel can work under extremely adverse conditions and may be exposed to toxic chemicals, safety hazards, physical hazards, biologic hazards and radiation hazards. These personnel, at any point in time, may be required to wear personal protective equipment (PPE) such as chemical resistant garments and various types of respirators. Wearing PPE places stress on the body which may include heat stress, cardiopulmonary stress, and claustrophobia. It may also aggravate other systemic illnesses.

Medical surveillance programs are designed to protect employee health from the hazards outlined above. OSHA regulations require a medical surveillance program for the Hazardous Materials Industry Technicians, who are members of organized and designated hazardous materials response teams. A medical surveillance program serves to assess critical values in employee health before, during, and after employment, as well as provide medical care during emergency response activities.

A medical surveillance program should be developed based on specific needs, location and the potential for exposure. The program should be developed and directed by an experienced occupational health physician or other occupational safety consultant in conjunction with the shipyard Safety Department. All medical test analyses should be performed by a laboratory certified at meeting the requirements of the Clinical Laboratory Improvement Act of 1967, or other scientifically accepted standards. One purpose of medical surveillance is to evaluate workers who are exposed to low concentrations of chemicals for many years. This chronic exposure may not cause any immediate noticeable response or symptoms of disease, however, they may provide an early warning of such exposure. This Session is not inclusive of all information regarding medical surveillance requirements. It is presented at an awareness level for the purpose of advising the Shipyard HazMat Technicians of their rights to a medical surveillance program.

What is Medical Surveillance?
Medical surveillance is a long-term study of worker health. It compares on-the-job exposures to possible health effects. Medical surveillance can help control known or suspected job hazards. A Medical Surveillance Program can help determine if controls within your workplace (engineering controls, administrative controls, or the use of personal protective equipment) protect worker health.

The Goals of Medical Surveillance are as Follows:

- Discover as quickly as possible any health problems related to your employment
- Analyze health problems and determine their causes
- Prevent health problems in the future, based on the knowledge gained from past medical surveillance programs

Who is included in the program?

- All workers who have been exposed to a level of a chemical equal to, or more than, the PEL for 30 days or more during the year
- All workers who have used a respirator for 30 days or more during the year
- All workers who have become ill due to contact with hazardous substances
- All emergency response workers

Preventing Heath Problems Through Medical Surveillance

Many health problems caused by workplace exposures are difficult or impossible to cure. Examples of such problems are asbestosis, lung cancer, leukemia, silicosis, and black lung disease.

Fortunately, most of the diseases caused by workplace exposure are preventable. The goal is to limit exposure to dangerous chemicals. There are three ways to affect the development of a heath problem:

1. Preventing Exposure
Eliminate the risk of exposure to hazardous chemicals before they can cause disease. Use engineering controls, administrative controls, and personal protective equipment

2. Detect Disease Early
Use medical surveillance and environmental monitoring to discover disease, before it becomes irreversible. Examples include blood testing to determine blood lead levels among workers who have been exposed to lead and testing for liver damage among workers who have been exposed to solvents.

3. Treat and Rehabilitate
Provide treatment for diseases to prevent the problem from becoming worse, even disabling. Examples are surgery to remove a tumor, or drug therapy to stop a disease once it has begun.

Medical Program Development

The program is to be fixed upon the specific shipyard responders needs based on potential exposures. The medical program should be directed by a physician who is board-certified in occupational medicine or a medical doctor who has had extensive experience managing occupational health services. A site medical program should provide the following components:

Recommended Shipyard Medical Program

COMPONENTS	DESCRIPTION
Pre-Employment Screening	Medical history screening Occupational history Physical examination Determination of fitness to work wearing protective clothing
Periodic Medical Examination	Yearly update of medical and occupational history Yearly physical examination testing based on: examination results, exposures, job class, and task More frequent testing based on specific exposures
Emergency Treatment	Provide emergency first aid on-site Develop liaison with local hospital and medical specialists Arrange for decontamination of victims Arrange in advance for transport of victims Transfer medical records quickly giving all details of incidents and medical history
Non-Emergency Treatment	Develop mechanism for non-emergency health care
Record Keeping & Review	Maintain and provide access to medical records according to Federal and State OSHA Report and record occupational injuries and illnesses Review Site Safety Plan regularly to determine if additional testing is needed Review program periodically focusing on current exposures and industrial hygiene

Determination of an Individuals Fitness for Duty

Employees at hazardous materials incidents are often required to perform strenuous tasks (i.e., moving 55-gallon drums) and wear personal protective equipment, such as respirators and protective clothing, that may cause heat stress and other problems. The pre-employment screening should

focus on the following areas to ensure that prospective employees are able to meet work requirements:

Occupational and Medical History

- Make sure the employee fills-out an occupational and medical history questionnaire.
- Review past illnesses and chronic diseases, particularly a topical disease such as eczema, and asthma, lung disease and cardiovascular disease.
- Review symptoms; especially shortness of breath or labored breathing on exertion, other chronic respiratory symptoms, chest pain, high blood pressure, and heat intolerance.
- Identify individuals who are vulnerable to particular substances (i.e., someone with a history of severe asthmatic reaction to a specific chemical).
- Record relevant lifestyle habits (i.e., cigarette smoking, alcohol and drug- abuse) and hobbies.

Physical Examination

- Conduct a comprehensive physical examination of all body organs, focusing on the pulmonary, cardiovascular and musculoskeletal systems.
- The physical examination should include the following:
    1. Height, weight, temperature, pulse, respiration and blood pressure
    2. Head, nose and throat
    3. Eyes
    4. Ears
    5. Chest (heart and lungs)
    6. Peripheral vascular system
    7. Abdomen, rectum, hernia
    8. Spine and components of the musculoskeletal system
    9. Genitourinary system
    10. Skin
    11. Neurological system
- Note conditions that could increase susceptibility to heat stroke, such as obesity and lack of physical exercise.
- Note conditions that could affect respirator use, such as missing or arthritic fingers, facial scars, dentures, poor eyesight or perforated eardrums.

Ability to Work While Wearing Protective Equipment

The physician performing the examination must perform the following:

- Disqualify individuals who are clearly unable to perform based on the medical history and physical examination (i.e., those with severe lung disease, heart disease, or back or orthopedic problems)
- Note limitations concerning the employees ability to use protective equipment.
- Provide additional testing (i.e., chest x-ray, pulmonary function testing, electrocardiogram) for ability to wear protective equipment where necessary.
- Base the determination on the individuals profile (i.e., medical history, physical examination, age, previous exposure and testing)
- Make a written assessment of the employees capacity to perform while wearing respiratory equipment, if wearing respiratory equipment is a job requirement. No employee should be assigned to a task that requires the use of respiratory equipment unless it has been determined that the person is physically able to perform under such conditions.

Baseline Data for Future Exposures

Pre-employment screening can be used to establish baseline data to subsequently identify changes in a responders health conditions. Baseline testing may include both medical screening tests and biological monitoring tests. The latter (i.e., blood lead level) may be useful for ascertaining pre-exposure levels of specific substance exposure when reliable medical tests are available. Given the problem in predicting significant exposures, there are no clear guidelines for prescribing specific tests. The following approach identifies the types of tests that may be indicated:

- A battery of tests based on the employees past occupational and medical history and an assessment of significant potential exposures.
- Testing for specific toxicants in situations where workers may receive significant exposures. Standard procedures are available for determining levels of a number of substances (i.e., lead, cadmium, arsenic, and organophosphate pesticides).
- Where applicable, pre-employment blood specimens and serum are frozen for later testing. PCBs and some pesticides are examples of agents amenable to such monitoring.

Three Parts of the Medical Evaluation

1. Medical and Occupational History

This includes information that you give the doctor concerning your health. It is the most important part of your medical evaluation. You should be prepared to answer the following questions:

How do you feel?
What symptoms do you have?
Are your symptoms affected by your work?
What are the dangers of your job?
What other jobs have you held?
Do other workers at your workplace have the same symptoms?
Do your symptoms continue when you are away from your workplace?
What, if any, personal protective equipment do you use?

When must employers provide medical evaluations?

- Prior to your job assignment at a workplace.
- At least once a year while working at the same workplace.
- At the end of employment, or when you are reassigned to another job (if you have not had a medical exam in the past six months).
- Immediately after you inform your employer of a symptom resulting from excessive exposure.

Information Provided to the Physician

When sending a worker for a physical examination there is specific information that must be provided to the physician, including:

- A description of the employees duties as they relate to potential exposures.
- The employees exposures or anticipated exposures.
- A description of any personal protective equipment used or expected to be used.
- Information from previous examinations that are not currently available to the physician.
- Information required by 1910.134 concerning respirators.
- A copy of the 29 CFR Standard and Appendices.

2. Physical Examination The physical examination should include an analysis of your physical condition and your ability to use personal protective equipment.

3. Laboratory Tests Various laboratory tests are available. It is very important that the tests performed are specific for the chemicals you are exposed to in your job. Blood tests, urine tests, and Serum tests are some tests that may be taken. There are several problems associated with laboratory tests:

- Many tests are not sensitive enough to detect a problem until it is too late.
- Most laboratory tests are not specific for diseases resulting from your job.
- Sometimes the results are incorrect.
- Laboratory tests do not exist for all types of health problems.

Physicians Written Opinion

After completing the medical evaluation, the doctor must write his or her "Medical Opinion". In the medical opinion, the doctor must state whether or not continuing to work at the present job will endanger the worker's life. He must send a copy of the medical opinion to the employer. The written opinion obtained by the employer shall not reveal specific findings or diagnoses unrelated to occupational exposure. The employer must maintain copies of all medical evaluations and according to the law, must give a copy of the medical evaluation to the employee. The physicians written opinion shall contain:

- The physicians opinion as to whether or not the employee has any detected medical conditions that would place him/her at increased risk.
- The physicians recommended limitations for the employees assigned work.
- The results of the medical examination and tests if requested by the employee.
- A statement that the employee has been informed by the physician of the results of the medical examination and any conditions that require further examinations or treatment.

Fitness For Duty Form: The physicians written opinion must be maintained at the site where the work is taking place and be available to an OSHA inspector. It is not necessary to have the full examination results at the site Those must be maintained in the employee medical file.

The Baseline Physical Examination

The baseline physical examination should be performed prior to a workers assignment to any duties where there is a potential for exposure to hazardous substances. This may be referred to as pre-employment screening. This establishes whether or not a worker has been previously exposed or has any medical problems that may preclude the worker from working in a hazardous environment. These physicals are used to establish a baseline that can be compared to additional examinations so that determinations can be made concerning metabolic changes that may be caused through exposure to chemicals.

Periodic Medical Examinations - Periodic screening

Periodic medical examinations should be developed and used in conjunction with pre-employment screening examinations. Comparisons of sequential medical reports with baseline data is essential to determine biologic trends that may mark early signs of adverse health effects and thereby facilitate appropriate protective measures. Persons working as emergency responders are required to be re-evaluated at intervals based on the physicians recommendations. Usually a physician will recommend an annual periodic examination.

Periodic screening may be required more frequently if a worker is believed to have been exposed. This may also occur during protective equipment failure. For example, if it is discovered that a workers respirator has not been operating according to the manufacturers specification, or an emergency occurs, such as a worker being splashed with a toxic solvent, a periodic examination would be required.

Periodic examinations focus on changes in health status, illnesses, and possible work related symptoms. The examining physician should have information about the employees exposure history, including exposure monitoring at the job site, supplemented by employee reported exposure history and general information on possible exposures at previous job sites.

Termination Physical Examination

At the end of employment all personnel must have a physical examination. If all three of the following requirements are met, this examination may be minimal as obtaining the medical history of the period since the last examination.

- The last full medical examination was within the last six months
- No exposures have occurred since the last examination
- No symptoms associated with exposure occurred since the last examination

If any of these three criteria are not met, a full examination is necessary at the termination of employment.

Other Functions of Medical Surveillance

1. Analyze and report the medical results of groups of workers.
2. Control hazards that have been identified in a workplace as a result of medical surveillance.
3. Assign other jobs at the workplace if the current job is found to be dangerous to an employees health (without loss of wages, benefits, or seniority)
4. Ensure the right to get a second medical opinion
5. Report to insurance companies all illnesses related to the workplace (for Workers' Compensation)

Limitations of Medical Surveillance

1. Does not prevent disease from forming.
2. Available tests may be invasive, expensive, potentially harmful, and insensitive,
3. Each program depends upon the proper selection, performance, and interpretation of medical tests by qualified and trained doctors.
4. Each program depends on the correct assessment of the hazards to which workers have been exposed. If you are not looking for a specific change, effect, or outcome, it is likely to be missed in a medical evaluation approach.
5. Analysis of group results is often lacking, and such analysis is key to early detection of disease.
6. It can lead to discrimination, loss of confidentiality, and/or mixing with other practices, such as random drug testing, if everyone involved is not careful to avoid such problems.

Record Keeping Requirements

Proper record keeping is essential due to the nature of the work and risks. Employees may respond to many incidents during their careers, adverse effects of long term exposure may not become apparent for many years. Records enable subsequent medical care providers to be informed regarding employee's previous and current exposures. The regulations outlined in 29 CFR 1910.120(f) for medical examinations require certain components of the medical program be

retained on file. OSHA regulations mandate that, unless a specific occupational safety and health standard provides different time periods, the employer must:

- Maintain and preserve medical records on exposed workers for thirty (30) years after termination.
- Make available to workers and their authorized representatives, the results of medical testing and full medical records and analysis.
- Maintain records of occupational injuries and illnesses and post a yearly summary report
- The records must contain the following information:
    - ◊ The name and social security number of the employee
    - ◊ Physicians written opinions, recommended limitations and examination results
    - ◊ Any employee complaints related to exposure to hazardous substances
    - ◊ A copy of the information provided to the physician by the employer

Emergency Medical Treatment Planning

Provisions for emergency treatment and acute non-emergency treatment should be made at each site. Preplanning is vital. When developing plans, procedures and equipment lists, the range of actual and potential hazards specific to the site should be considered. These should include chemical, physical and biological hazards. HazMat Technicians, contractors, and other personnel may require emergency treatment. Therefore, shipyard emergency medical treatment should be integrated with the overall Site Safety Plan. The following guidelines are recommended for establishing an emergency treatment plan:

Guidelines for Emergency Medical Treatment
Train a team of site personnel in emergency first aid. This should include a Red Cross certified course in Cardio Pulmonary Resuscitation (CPR) and first aid training that emphasizes treatment for explosion and burn injuries, heat stress and acute chemical toxicity. In addition, this team should include an Emergency Medical Technician (EMT), if possible.
Train personnel in emergency decontamination procedures.
Pre-designate roles and responsibilities to be assumed by personnel in an emergency.
Establish an emergency first aid station on-site, capable of providing: - Stabilization for patients requiring off-site treatment. - General first aid (e.g. minor cuts, sprains and abrasions.
Locate the station in the Support Zone, adjacent to the Contamination Reduction Corridor, to facilitate emergency decontamination. Provide a standard first aid kit, or equivalent supplies, plus additional items such as emergency deluge showers, stretchers, potable water, ice, emergency eyewash, decontamination solutions, and fire-extinguishing blankets.
Establish an on-call team of medical specialists for emergency consultations (i.e., toxicologist, dermatologist, hematologist, allergist, opthamologist, cardiologist and neurologist. Develop plans in advance for emergency transportation to, treatment at, and contamination control procedures for a nearby medical facility.
Educate local emergency transport and hospital personnel regarding possible medical problems, types of hazards and their consequences, potential for exposure, and function of the site medical program.
Post conspicuously (with duplicates near telephones), the names, phone numbers, addresses and procedures for contacting: On-call physicians, medical specialists, ambulance services, medical facilities, fire and police, poison control hot-line.
Provide maps and directions and make sure that all managers, and all individuals involved in medical response, know the way to the nearest emergency medical facility. Establish a radio communication system for emergency use.

Session 13. Heat Stress Concerns When Wearing CPC

The most common cause of injury to HazMat Technicians involved in hazardous materials incidents is heat stress induced by wearing chemical protective clothing (CPC). With the availability of high capacity air supplies and protective clothing, the restricting factor for work periods has become the responders health concerns, associated with heat stress. Shipyard Incident Commanders and HazMat Technicians must adequately assess the health threats to all workers in CPC. Heat illness management techniques and medical monitoring of emergency response personnel are the principal concerns.

Both physiological and psychological stress can severely affect response personnel. Under certain conditions, stress can contribute significantly to accidents and harm workers. This Session will provide information about stress factors encountered by shipyard response workers and discuss the associated aspects of a medical monitoring program.

A complete program to reduce the potential for physical stress and mental anxiety during emergency response should be incorporated into the shipyards safety program and should include:

- Periodic examinations of workers by medical authorities to determine if they are physically, and, if possible, psychologically fit to perform their duties.
- Continual practice and training in using PPE, especially air supplied respirators and CPC suits.
- A medical monitoring program for incident and non-incident responder health management

Many HazMat Technician responders tend to underestimate the risks to personnel working in CPC because they focus on the environment, response procedures, victims, and the hazardous substances. They frequently fail to adequately recognize the health risks associated with wearing CPC. Technological advances in CPC, such as SCBA, and air-line systems, make it possible to work in hazardous environments for long periods of time. This presents a significant increase in the health risk to personnel as they become limited more by their own physical conditions, than by the limitations of their protective equipment. In many cases, the CPC can become a "hostile interior environment" as personnel are subjected to 100% relative humidity and elevated temperatures within 7 minutes of donning the suit.

4 Major CPC Stress Factors

Wearing CPC puts personnel at considerable risk for injuries ranging from heat-related illnesses to physical traumas, chemical toxicity, or psychological harm. Conditions related to the incident (the environment, the CPC itself, difficulty and duration of the work performed, etc.), are part of the problem. Stress factors can lead to responders becoming injured or affected by heat stress when working in hazardous environments wearing CPC. Personnel operating in CPC are typically subjected to four types of stress factors, environmental, mechanical, psychological, and physiological.

Environmental stress factors include temperature and humidity both outside and inside the CPC. Wind conditions, terrain, confined spaces, and sunlight are all environmental stress factors. These factors can affect both the physical and mental state of responder wearing CPC. These factors must be taken into account during work mission planning activities.

Mechanical stress factors are caused by faults or defects in the protective equipment, physical limitations inherent in the CPC (mobility, dexterity, visibility, etc.), and/or objects that come into

contact with the garments creating punctures, tears, rips or abrasions. Close inspection of the suits, careful planning at the incident, and attention to detail, are the best preventative techniques for managing mechanical stress factors. The table below describes some common stress factors in more detail:

Mechanical Stress Factor	Description
Decreased Worker Agility	This can be a major problem for some operations. A worker losses a great deal of agility when wearing some protective equipment. Tasks requiring good hand agility are very difficult when wearing protective gloves. A worker also has a decreased sense of balance when wearing equipment such as protective suits and respirators. Simple tasks require substantial extra time, energy and effort.
Decreased Vision	Workers wearing protective suits and full-face respirators have a decreased field of peripheral vision. This may present a real danger when workers wearing protective equipment are required to operate or work around heavy equipment such as cranes, backhoes, trucks, or front end loaders.
Decreased Hearing	Hoods, respirators and hearing protectors decrease the workers ability to hear. This can interfere with communication and present increased risks especially with decreased vision.
Communication	Communication may be very difficult or almost impossible when wearing protective equipment, such as encapsulating suits and respirators. Communication systems integrated directly into the protective suit or respirator are available. The "buddy system" is practiced whenever personnel are required to wear protective equipment. Buddies should have understandable hand signals and maintain constant contact when in the work area. Some hand signals may include signs such as "thumbs up" if everything is O.K., "hands gripping throat area" meaning low on air or "thumbs down" meaning something else is wrong. When a signal is given that indicates that there is a problem, both workers using the buddy system should leave the hot zone and proceed to the decontaminationtamination area.

Physiological stress factors are created by the physical characteristics of the individual (age, fitness, health and personal habits). The use of CPC requires an additional workload. The effect will vary depending on the individual and the level of CPC being used. The table below describes some common physiological stress factors:

Physiological Stress Factors
Lack of physical fitness is an avoidable condition that should not be tolerated. Shipyards should develop doctrines that encourage only the most fit to use CPC and be members of a hazardous materials team. Personnel who have low work capacities are more susceptible to heat-related injuries.
Lack of familiarity with the personal protective equipment is another inexcusable factor in injuries. HazMat Technician responders should practice and drill with various CPC until they are totally comfortable with them.
Age affects personnel in a number of ways including: general health, reaction time, stamina, and dexterity. Younger individuals are often preferred for assignments that require working in CPC. However, older individuals, who are physically fit and experienced in dealing with hazardous materials, are a valuable resource, and should not be overlooked merely due to age.
Dehydration caused by sweating, diarrhea or other conditions is one of the principal causes of heat-related injuries. Therefore, anyone who exhibits symptoms of dehydration (unusual thirst, etc.), or signs of other maladies, should not be assigned duties that require the use of CPC.
Obesity causes excessive stress on the body, especially to the cardiovascular system, even under normal conditions. Wearing CPC will put additional stress on the body. Obese individuals should not be chosen for tasks requiring the use of CPC.
Personal habits can greatly affect an individuals health. Alcohol, smoking and drug use can result in diminished lung capacity and mental alertness. Even an individual who is experiencing the effects of a "rough night" should be barred from wearing CPC. Over the counter medications, especially decontaminationgestants and antihistamines, may increase the risk of heat stress.

Infections or other illnesses preclude personnel from operating at "peak efficiency." Strenuous physical activity will further deplete their already overtaxed energy and immune systems. In addition, these individuals should not come into contact with others to whom they may spread their illness or infection.
A sunburn can cause extreme discomfort when its irritated. The body is already coping with one injury. Aggravating that injury may cause further damage to the individual.
Diarrhea depletes large amounts of body fluids. Expecting a dehydrated individual to operate in an environment where fluid loss is the greatest hazard is to gross negligence. Diarrhea may also cause other problems for personnel confined in an encapsulating suit.
Chronic diseases, such as emphysema and bronchitis, can severely limit the physical capabilities of personnel. Emergency response personnel who manifest signs of chronic illnesses should be prohibited from joining hazardous materials teams.

Physical condition and fitness is a major factor influencing a workers ability to function under heat stress conditions. The more fit a worker is, the more work can be performed. At a given level of work, a fit worker, relative to an unfit worker will have:

- Less physiological strain
- A lower heart rate
- A lower body temperature
- A more efficient sweating mechanism
- Slightly lower oxygen consumption
- Slightly lower carbon dioxide production

Level of Acclimation: A workers ability to work under heat stress is highly dependent on how well the body has acclimated. A worker who is acclimated has a lower heart rate and body temperature. These workers will also sweat sooner and more profusely. Sweat composition is more dilute for fit workers, thus less salt is lost. NIOSH recommends 6 days for the worker to become acclimated before allowing a full work day on a hot job.

Psychological Factors are manifested by anxiety and/or claustrophobic reactions to operation in adverse environments, with dangerous materials, or under unfamiliar conditions. These may be due to the incident, individual reactions, or the chemical protective equipment itself. Often these psychological stresses have lingering effects that must be dealt with using incident stress debriefings and/or individual counseling conducted by trained professionals.

Anxiety may be overcome with time and training. Claustrophobia is too serious of a condition to risk an employee's health. No one with this condition should be allowed to work in CPC, particularly the encapsulating suits. This problem should be obvious upon a report from a physician when the baseline physical is completed.

Heat and Humidity Factors

Field air and environmental monitoring must include conditions relating to the health and well-being of emergency response personnel. Temperature, relative humidity and wind speed are the minimum components necessary to define the environmental parameters for personnel at the site.

Ambient air temperature and relative humidity are combined to determine the "heat index." This index is a measure of the body's ability to cool itself. When the air is already high in moisture, less moisture can be removed from the body. In other words, humidity decreases the effectiveness of evaporation and general cooling.

Physical Heat Responses

The combination of physical exertion and lack of cooling begins to raise the body's core temperature. As the internal temperature rises, the body starts various control functions to moderate this heat. Increasing amounts of blood are shunted from the core to the outer layers of skin. Greater amounts of sweat are produced for evaporative cooling. The heart begins to pump faster and harder to move more volumes of heat to the surface.

The body begins to lose ground when the heat cannot be dissipated quickly enough. The internal heating process continues, building more heat that still cannot be dissipated by normal body mechanisms. Eventually, the thermal regulatory system is overwhelmed.

The circulatory system functions to deliver oxygen and fuel to the individual cells. Blood, carrying these essential nutrients is delivered through a regional system of arteries, arterioles, capillaries and capillary beds. This network can be regulated by the brain to carry only the amount of nutrients needed by each area of the body. However, this system can also be overwhelmed. When that happens it leads to a condition known as anaerobic metabolism. This is a condition where oxygen is no longer supplied in sufficient quantity to continue the metabolic process that converts food to energy and nutrients (amino acids, carbohydrates, etc.).

Heat Exchange and Transfer

The terms conduction, convection, radiation and evaporation are used to describe heat transfer. The metabolic process is restricted by the laws of physics to utilizing these same processes in the conversion of food energy. The following table provides a quick review of heat exchange methods:

Heat Exchange Methods
Conduction is the transfer of heat between two solids, or a solid and a liquid, that are in contact with one another. The dissipation of heat through conduction is minimal for emergency response personnel. This typically only occurs when the responder's body comes in direct contact with the CPC suit material, or a cooling unit under the suit.
Radiation is the transfer of heat between two bodies that are not in direct contact with each other. This transfer occurs as electromagnetic waves that carry energy from an emitter (radiator), outward in all directions, to a receiver. An example of this is the heat radiated from asphalt on a hot day. Objects that emit electromagnetic energy greater than 95^{o}F are heat radiators to the human body. Color is another heat variable. Lighter colored objects or materials tend to reflect the majority of the electromagnetic energy that strikes them, while dark objects tend to absorb most of that energy. This means that light colored CPC suits will absorb some radiated heat, and far less than the darker suits will.
Convection is the transfer of heat that does not involve a phase change. Simply stated, convection utilizes liquid or gaseous mediums to transport heat energy to other objects. These liquid or gases pick up the heat and carry them to other objects where they can be absorbed. An example of this would be cool air blowing against dry skin. This form of heat exchange is also of little use to responders wearing CPC due to the insulating properties of the suit. As responders exhale air into the suit, the suit expands, creating an air void that limits the transfer of heat (or cooling).
Evaporation is the transfer of heat using a phase change. This phase change utilizes heat carried by a liquid such as sweat. As air travels over this liquid, heat energy is absorbed by the air, through evaporation, and carried away from the body. Evaporation is the major process, for body cooling. CPC is utilized by responders because it is impermeable to the transfer of vapors. This same quality renders the garments totally ineffective to the transfer of heat away from the body by evaporation.

Work Tolerance

CPC directly influences work tolerance. Heavy, bulky suits are much more difficult to work in than lighter suits. Level A suits have been known to reduce work tolerance by as much as 50%. This slight margin of comfort created by multi-piece suits, helps explain their popularity over totally enclosed suites.

As the work duration increases, heat tolerance decreases. CPC severely reduces the effectiveness of normal heat exchange mechanisms such as evaporation of sweat, convection from cooling currents and radiation of body heat. The interior of the suit begins to behave much as a sauna does, with temperatures rising to well over 100°F. The temperature inside the suit can be more than 25% higher than the external ambient temperature. At the same time, interior suit humidity rises until it is near 100%. This not only severely represses the body's cooling mechanisms, it acts to reflect that heat back towards the body, elevating core temperatures even further. The result can quickly become catastrophic if the metabolic processes are not managed properly. For example, studies have shown that personnel wearing Level A CPC and working hard in a typical summer climate, lost approximately 5% of their body weight in the duration of just one air bottle (about 45 minutes). This completely disrupts normal blood chemistry and is a very dangerous medical condition.

Heat Related Injuries (Heat Stress and Illness)

The protective clothing that shields the body from chemical exposure also limits the dissipation of body heat and moisture. Heat stress may occur very rapidly, in as little as 15 minutes. If the body's physiological processes fail to maintain a normal body temperature, and excessive heat is allowed to build up, a number of physical reactions can occur. These may range from mild (fatigue, irritability, anxiety, decreased concentration and dexterity) to fatal. Some symptoms exhibited by workers in early stages of heat stress, if overlooked, may lead to heat stroke and death. A few of the symptoms and treatments for heat illness are as follows:

Type of Illness	Causes/Symptoms	Treatment
1. **Heat Cramps**	**Are caused by heavy sweating with inadequate electrolyte replacement** • Occurs due to strenuous activity in a warm environment • Inadequate fluids • Cramping, pain, and spasms of legs and abdominal muscles • Heavy sweating and water loss	• Rest in cool shady place • Drink liquids to replace water loss • Light stretching and massage
2. **Heat Rash**	**May result from continuous exposure to heat and/or humid air.** • Sweat ducts become plugged • Rash develops • Skin remains wet (especially in hot, humid environments)	• Rest in cool area • Frequently dry skin
3. **Heat Exhaustion (Rarely Fatal)**	**Is caused from increased stress on various organs of the body, including inadequate blood circulation due to cardiovascular insufficiency or dehydration** • Pale, clammy skin • Heavy sweating • Large pupils • Rapid, shallow breathing • Weakness, dizziness, headache • Nausea, vomiting	• Take to cool place • Remove CPC • Treat for shock • Give fluids if conscious • Rest

4. <u>Heat Stroke (Sunstroke) Can be Fatal</u>	**This is the catastrophic failure of the body's thermoregulatory system and is a true medical emergency** • Very hot and dry skin/no perspiration • Body temperature is 105 degrees or Higher • Confusion and delirium • May become unconscious	• Take to cool place • Remove CPC • Treat for shock • Cool with ice, cold water and fan • **Get Medical Help As Soon As Possible**

Treatment of Heat Illnesses

Anyone who exhibits the signs or symptoms of a heat related illness requires immediate medical attention. These individuals should be removed to a shaded area and cooled by evaporative or active cooling methods. The treatment for all heat related injuries includes maintaining vital signs, rehydrating and cooling the patient. Continue to monitor the patient, and transport to the nearest medical facility, if appropriate.

Heat Stress Prevention

It is important to implement good safety procedures to prevent workers from succumbing to heat stress. The following is a list of ideas that should be integrated into the shipyard CPC stress prevention program:

1. Avoid overprotection by specifying a level of protection that is not necessary. In simple terms, the level of protection should be adequate and at the same time avoid overkill.
2. Train to ensure that supervisors and workers are aware of all symptoms and work conditions related to heat stress.
3. Monitor personnel for signs and symptoms of heat stress by site safety personnel.
4. Replacement of body fluids will help ensure that the cardiovascular system functions properly.
5. Fluid intake should equal the amount of water lost through perspiration. For example, if 8 ounces of body weight is lost from perspiration it should be replaced with 8 ounces of water. Workers should be informed to drink water, when heavy sweating occurs, as the body thirst mechanism is not sensitive enough to trigger enough drinking. Keep employees hydrated using the following methods:
   - Provide drinking water cups with a capacity of 4 ounces.
   - Maintain drinking water at a temperature of 50F to 60F.
   - Have workers drink about 16 ounces of water before starting work.
   - Urge workers to drink a cup or two of water at each break.
6. Weigh workers before and after work to determine if fluid replacement is adequate.
7. Work schedule adjustments should be made based on the adjusted temperature conditions and if symptoms are exhibited by workers indicating the early signs of heat stress.
8. Provide good shelter such as shaded areas or air conditioning.
9. Encourage, teach and require a level of fitness for responders.
10. Acclimatize all responders by performing lighter work in non emergency situations in preparation for responding to incidents.

Medical Monitoring

The need for medical monitoring guidelines is heightened by the pressures placed on emergency responders by their supervisors, peers, and their own individual motivations, to continue working when it is no longer safe for them to do so. Fortunately, OSHA requirements specify medical monitoring as a component of the Site Safety Plan. This reduces the chances that individuals may

exceed their physical limitations due to inappropriate motivations. However, we must also recognize that medical monitoring has certain implications.

Medical support and assessment is an important element of an effective hazardous incident response. Medical monitoring should be initiated before entering and after exiting the Exclusion Zone. More important than the legal requirements for medical monitoring, is the personal impact of monitoring on the individual. We already know that heat related illnesses are the number one health risk to emergency responders at hazardous materials incidents. Heat related illnesses are most prevalent during warm or hot weather. Monitoring vital signs provides the best method to prevent or identify these conditions.

Monitoring procedures are not limited to field locations. The regulations designate two types of programs; baseline medical exams and field monitoring programs. Medical monitoring is a multi-faceted program that is predicated on the status of the individual. Employees who have hazardous materials incident response functions as a regular, expected function of their employment, must have baseline medical examinations, as well as pre-entry and post-entry monitoring. Baseline medical evaluations are conducted under the guidance of a physician and are done biannually, annually, or prior to response. Pre-entry physicals are routinely conducted by field Emergency Medical Personnel who should be assigned exclusively to this duty at the scene.

Emergency response personnel must establish a medical monitoring station at each hazardous materials incident. The medical monitoring site should be located near the "dress out" area for the Entry and Decontamination Team personnel. If possible, this should be in a cool, shaded location away from noise and other distractions. All pre-entry and post-entry vitals that are taken must be documented. Therefore, shipyards should establish some sort of record keeping system to document these vitals.

Elements of an Effective Medical Monitoring Program

Advances in medical science have altered our understanding of what constitutes heat illnesses. Previously, the belief was that the best indicators for measuring heat distress were accomplished by assessing the patient's temperature, heart rate and blood pressure. Now it is accepted that a more accurate assessment is gained by measuring the patient's body core temperature, heart rate and water weight loss. Therefore, an effective medical monitoring program should include assessments of these essential factors. The items in the following table should also be implemented:

Vital Sign	Procedure
Heart Rate	Monitored by counting the radial pulse during a 30 second period, as early as possible during the rest period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle should be shortened by one third, and the rest period should remain the same length. If at the beginning of the next rest period the heart rate still exceeds 110 beats per minute the next work cycle should be shortened by one third.
Oral Temperature	Should be monitored using a clinical thermometer at the end of the work period prior to drinking water. If the oral temperature of workers exceeds 99.6^{o}F, the next work cycle should be shortened by one third and the rest period should remain the same length. If at the beginning of the next rest period, the oral temperature still exceeds 99.6^{o}F, shorten the next work cycle by one third. If the oral temperature of any worker exceeds 100.6^{o}F, impermeable clothing should not be worn.

Body Water Loss	Body water loss should be measured using a scale accurate to plus or minus 1/4 pounds. Workers should be weighed at the beginning and end of each work day. Weights should be taken with workers wearing the same type of clothing for each weighing. Body water loss should not exceed 1.5% of the total body weight.
Pulse or Heart Rate:	The pulse is the best indicator of the overall stress being applied to the body. It is a direct measurement of how fast the body is attempting to cool itself, and it indicates the aerobic exercise recently generated by the individual. The most widely accepted pulse measurement is known as the "Age Adjusted Maximum Heart Rate. " This figure represents the limit to which an individual can maintain aerobic exercise for extended periods without damaging the heart muscles. However, this number should never be exceeded by personnel. To figure the Age Adjusted Heart Rate, subtract the individual's age from the number 220. “**Adjusted Heart Rate = (220 - age)**
Blood Pressure	Blood pressure is a health component that is not believed to be affected by heat stress, and does not require constant monitoring. However, it is a measurement of the "quality" of rest by the heart muscle between each stroke and is worth tracking.
General health	General health of the responder is an overall indicator of the responders fitness for stressful working environments. This includes general physical appearance and identification of personnel who haven't been feeling well lately.

Body Weight and Body Temperature are Extremely Important Factors

Body Weight: It is possible for individuals to have a sweat rate as high as 3.5 liters per hour when they are wearing CPC. Fluid loss is an element of heat stress management that cannot be made up quickly. Fluid metabolism is a slow process that must occur throughout the day to be truly effective. A good rule of thumb for fluid replacement is to administer the equivalent amount of fluid weight as was lost through the incident activity. When considering the administration of fluids, do not rely on the patient's thirst level alone. This is a deceptive indicator. A more accurate indicator is deep yellow colored urine. However, false indicators from certain vitamins and various foods can also create this condition. Do not guess. Rely on measurable indicators: body weight loss using a scale accurate to within 1/4 of a pound. Suggested water weight loss parameters are:

- Body weight loss should not be allowed to exceed 1.5% of total body weight.
- A 3% loss of body weight should require that the individual be immediately removed from all duties pending a thorough assessment by a qualified medical authority.
- A 5% loss of body weight should require that the individual be immediately transported to the nearest medical facility for a thorough assessment.

Be cautious when taking the post-entry body weights. Post-entry assessment is intended to weigh the amount of fluid remaining in the body tissues. Weighing individuals who have rehydrated or are still in sweat soaked garments defeats the purpose of the measurement. Pools of liquid in the stomach or hanging on the body serve no immediate value and may mask a serious condition, Make sure the post-entry weight is a "dry" one.

Body Temperature: The most common form of body temperature assessment is the oral thermometer. However oral temperatures are not accurate enough to rely on for determining patient well-being. The second option is hardly practical in the field. Even though rectal temperatures are the most representative deep core temperature indicator, few responders would consider them to be appropriate at a hazardous materials site. The third option provides the best solution. Tympanic temperature readings (taken through the ear drum) are a good indicator of body core temperatures

and are relatively easy to acquire. The best method of accurately determining an individual's temperature rise is by establishing a baseline prior to the event. This is accomplished by measuring the temperature every day over a two week period. However, this is not always an easy task to accomplish. Guidelines for body temperature monitoring are as follows:

- A maximum rise in temperature should not exceed 1.5 degrees Fahrenheit, upon post-entry examination.
- No personnel should be permitted to continue working until their temperature has returned to within 0.5 degrees of normal.
- To be valid, the temperature must be acquired as quickly as possible after the individual has exited the work zone.

Fluid Replacement, Rest, and Recuperation

The Medical Monitoring plan must address every factor pertinent to the full recovery and return to work of all personnel. These factors include: fluid replacement, rest, and heart rate recovery. Water is the best fluid replacement. Sweetened drinks tend to inhibit the metabolic process that restores water to the cells, as does carbonation. However, personnel should be allowed to drink something that they like. Fruit juices and electrolyte solutions should be diluted with water prior to consumption. This will improve the body's ability to assimilate these liquids. Alcohol and caffeinated drinks should never be permitted because they actually promote dehydration, as do salt tablets.

Providing adequate rest periods between work missions is just as important as limiting the work mission duration. The EPA has established guidelines for responder rehabilitation times, based on research of endurance rates. This is one tool which is available to response teams. Drills and training exercises should be used as an avenue to measure, and test, rest period duration's in given environments. However, regardless of how an agency determines adequate rest periods, the time frames must be predicated by measurable factors such as anticipated work levels, environmental conditions, type of protective garments, individual workers characteristics and fitness, and medical monitoring results.

The medical monitoring plan may use a variety of methods to determine rest and recuperation periods. As an example, aerobically fit personnel, working under normal conditions for twenty minutes should rest as recommended in the following table:

Suggested Rest and Recuperation Guidelines for 20 Minutes Work

Ambient Air Temperature	Rest Period
< 70°F	30 minutes
70-85°F	45 minutes
> 85°F	60 minutes

Minimum recovery guidelines must be utilized to determine when personnel have returned to a condition where they may wear CPC, and return to a work zone again. The minimum suggested health guidelines are shown in the table below:

Minimum Suggested Field Medical Monitoring Guidelines

Vital Sign	Minimum Guideline
Temperature	A return to within .5 degrees of normal
Body Weight	A return to within 1.5% of normal
Pulse	A return to within 5%, and < 90 beats per minute
Blood Pressure	< 150/90

These guidelines may be amended, deleted, or added to, based upon the guidance of your emergency response physician.

Guidelines for Removing Workers From Duty

Responders removed from work due to the following medical signs are not allowed to return to work until cleared by a qualified medical authority:

Vital Sign	Point at Which Responders Should Be Removed from Work
Body Temperature	> 38'C (100.4'F) - This is an OSHA requirement
Pulse	> 85% of the maximum heart rate (Maximum 220 - age) > 110 beats per minute while the individual is at rest
*** Heart rate recovery**	< 10 beats per minute
Body weight loss	>3%
Other	Other signs and symptoms of heat related illness, such as skin temperature and cardiac rhythms

*** Heart rate recovery** is measured by taking the first and third minute pulse rates immediately upon exiting the work zone and then determining the difference. It is stated as: (Heart rate recovery = 1 min. rate - 3 min. rate)

Maintaining Adequate Blood Sugar Levels

One parameter that is seldom considered, but can be important, is maintaining adequate blood sugar levels. This is particularly important for individuals who are known to be diabetic or hypoglycemic. Once the blood sugar level starts dropping, a person may experience irritability, difficulty concentrating, or difficulty making decisions. This can be dangerous at a hazardous substance incident. It may be necessary for response personnel to eat a light snack before making entry into an incident just to keep the blood sugar level stable. If it becomes clear that the incident will be an extended one, the Incident Commander may need to arrange for food to be brought to the site for all personnel.

Session 14. Hazard and Risk Assessment

The evaluation of hazardous substance information, and the assessment of relative risk, is one of the most critical points in the decision making process at a hazardous materials incident. Before a decision regarding what actions to take can be made, facts concerning hazards and risks must be gathered and analyzed. While first responders recognize the need for isolating the area, denying entry, and identifying the hazardous materials involved, the HazMat Technician must be able to perform a hazard and risk assessment, in order to develop a successful plan of action.

Introduction to Hazard and Risk Assessment

Hazard and risk assessment simply means to "size-up" the situation at hand. It is a process of taking all the factors involved, weighing them, and arriving at a sound decision. Collecting and understanding information is required for the following:

- Chemical hazard analysis for environmental health and safety,
- Site safety and environmental site characteristic risk assessment, and
- Risk evaluation and visualizing potential outcomes for determining initial response actions.

The process involves locating information on the substance and evaluating of the situation at hand. Filling out incident information form is an excellent method for performing this function. Information forms and checklist are used to focus the process on the hazards. Three forms for hazard and risk assessment are provided as attachments and are listed below:

Attachment #1 Hazardous Substance Data Sheet
Attachment #2 Incident Hazard Risk Assessment Data Sheet
Attachment #3 Containment and Control Options and Objectives Sheet

Chemical Hazards in the Shipyard

A “hazard” is any situation which has a potential for causing damage to life, the environment and/or property. In hazardous materials related incidents, a hazard refers to the chemical and physical properties of a material. Examples include:

- Toxicity
- Flammability
- Reactivity
- Radioactivity
- Corrosivity

In hazardous materials related incidents a hazard risk refers to the hazardous chemical and physical properties that have a potential for causing damage to life, the environment and/or property. The chemical hazard analysis includes identifying the materials involved and their associated hazard risks to employee health and the environment. Placards, container labels, MSDSs, NAERG96, and/or knowledgeable persons on the scene are valuable information sources. All available information should be evaluated to reduce immediate risks. The process generally includes:

- Locating and reviewing the MSDS
- Identifying the Hazardous Label
- Looking up the Material in the NAERG96

Other Relevant Sources of Information:

- Pre-plans and Shipyard Emergency Plans
- Reference Source Books
- Computer Data Bases
- Emergency Response "Telephone Hotlines"
- Technical Experts On-site or Off-site

Chemical Hazard Assessment

One of the most critical aspects of a hazardous materials incident is the hazard assessment. One cannot identify and assess the problem if they do not understand the chemical involved and determine it's hazardous characteristics. A tremendous amount of information is needed to evaluate the hazards involved. This can be a long process if the information is not readily available. The best process for hazard assessment is to use a standard shipyard Hazardous Substance Data Sheet. An example Hazardous Substance Data Sheet is provided at the end of this Session as Attachment #1. The form should be used in conjunction with the following:

- The shipping name of the material (on shipping paper or bill of lading)
- MSDS information for chemicals present
- The DOT hazard class
- UN four digit identification number
- STCC number - Standard Transportation Commodity Code (Used by the Railroads.)
- CAS number - Chemical Abstract Service number (Used by state and local Right-to-Know regulations for tracking chemicals)
- Field Identification (Five-Step or Hazardous Category Identification)

Determining the physical description of the material
(Fill out a Hazardous Substance Data Sheet, Attachment #1):

Understanding the physical properties of the chemical

- Specific gravity, vapor density, vapor pressure
- Melting point, boiling point, solubility
- The chemicals physical state: (solid, liquid, gas, color, odor)

Identifying the health hazards

- Acute versus chronic hazards
- Exposure hazards (inhalation, ingestion, absorption)
- LD50 or LC50
- TLV and PEL
- Carcinogen
- Mutagen

Learning the fire hazards of the chemical

- Flash point, Ignition temperature
- Flammable range, toxic products of combustion
- Extinguishing agent

Understanding the reactivity hazards of the chemical

- The ability of a material to undergo a chemical reaction with the release of energy or heat
- Water reactive materials
- Pyrophoric materials
- Materials that undergo polymerization

Identifying the corrosive hazards of the chemical

Acid (pH =<7) Base (pH = >7) Neutralizing agents

It is important to remember that no planning, strategic, or tactical decision should be made on the strength of just one data source. Hazard data should always be double-checked using at least three (3) data sources.

Preliminary Risk Assessment

The definition of risk is the probability that damage to life, property, and/or the environment will occur. The risk can be considered greatest when the responder does not know the types of substances involved. This is why Level A/B protection is required when the materials are unknown. Risk assessment considerations include the following:

- Quantity and toxicity of materials
- The exposure potential to people, property and the environment
- Size, type, and condition of container
- The levels of resources available
- The weather conditions and the site terrain

The definition of risk is the probability that damage to life, property, and/or the environment will occur. Risks include those intangibles that cannot be looked up in any reference source or data base. Attachment #2 provides an example Incident Hazard Risk Assessment Data Sheet. These are risk assessment considerations that include:

Size and type of container and quantity of material involved.

- Risks will often be greater when dealing with bulk quantities of hazardous materials, as compared to limited-quantity, individual containers.
- The type of material will also be a significant factor. For example, metal, plastic, fiberboard etc.
- Another obvious and critical factor would be whether or not it is a pressure, or nonpressure, vessel.

The nature of the container stress must also be considered.

- Is the container rusted or corroded?
- Has the container been punctured or torn?
- Is the container leaking?
- Is the container bulging or dented?
- Has the container been exposed to flame or heat?
- Have any valves or piping been damaged?

The potential behavior of the container and it s contents must be determined. The behavior of the container will depend on:

- It's type and size.
- The physical and chemical characteristics of the material it contains.
- The condition to which the contents are subjected.

The levels of resources available must be considered.

- What Personal Protective Equipment is available?
- What is the level of training of personnel?
- What containment equipment is readily available?
- Is equipment available to effectively handle the incident? Is heavy equipment needed?

What is the exposure potential to people, property and the environment

- Where will the material go?
- What route will the material take (air, water, land, etc.)?

The weather conditions and the terrain must be taken into account.

- Wind direction and speed.
- Temperature.
- Is it raining or is it a hot, dry day?
- What is the topography? Is it flat, are there hills?
- Will the topography affect the approach or evacuation considerations?

The risks associated with hazardous materials response will never be completely eliminated. They can be successfully managed.

Evaluating Risk

Risk evaluation is the analysis of the "inputs". Specifically, the substance involved, the container, the environment in which the incident occurs, and finally, the actions and resources of the response personnel. All events will follow a logical sequence. For example, a container with a leak in the bottom will continue to leak until action is taken to stop the leak, or the contents leak out. The HazMat Technician must first estimate likely harm without intervention, before deciding to intervene or not. This requires the responder to visualize the likely behavior of the material and/or its container, and to describe the outcome of that behavior.

Visualize Potential Outcomes

Predicting potential outcomes form the basis of risk evaluation and developing initial response actions. The following is a list of questions that should be asked when visualizing potential outcomes:

- Where will the hazardous material go when it is released during an emergency?
- What humans can be affected by the material release?
- What pathway will the hazardous material and/or the container take to get there?
- How will the hazardous material affect humans or the environment?
- When will the hazardous material become an actual event?
- What harm will the hazardous material cause?

When considering the answers to the above questions, the Operational Responder must take into account the following factors which affect hazardous material behavior:

- The inherent properties and quantities of substance(s) involved (toxics, corrosives, flammables)
- The built-in characteristics of the container (round, plastic, steel, box, square)
- The natural laws of physics and chemistry (liquids, gases, vapors, solids)
- The pertinent environmental factors: (weather, wind, physical surroundings, slopes, streams)

The overall objective of the HazMat Technician at a hazardous materials incident is to favorably change or influence the outcome. These outcomes are defined in terms of fatalities, injuries, property and environmental damage, and systems disruption.

Control and Containment

Offensive control and containment options are reserved for the HazMat Technicians due to their specialized training and experience. Understanding containment and confinement controls, and safe work practices, during an incident, will help the HazMat Technician make these critical decisions. Careful planning is the key to safely and effectively containing any release. Hazardous materials spills/releases should be contained as quickly as possible to eliminate or reduce the hazard, prevent contamination of people and the environment, and to facilitate cleanup. Containment and control options are discussed in detail in a further session although it may be appropriate to fill out the Containment and Control Options and Objectives Sheet provided as Attachment #3.

Attachment #1 - Hazardous Substance Data Sheet

Material Information
- Shipping name ________________ Emergency phone # ______________________
- Chemical name ________________ Manufacturers phone # ____________________
- DOT Hazard Class _____________ UN / NA ID# ____________________________

Physical Description
- Physical Form Solid _____ Liquid ______ Gas _______
- Color _______
- Odor ________
- Other ________
- Hazardous components Chemical Name CAS # % by wt.

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____
____
____

Properties
- Specific Gravity ________ Density _______________
- Vapor Density _________ Boiling Point ___________
- Melting Point __________ Solubility in Water (Yes or No)

Toxic Human Hazards
- Inhalation hazard (Yes or No)
- Symptoms of inhalation exposure ____
- TLV/ TWA _________________ (ppm (mg/m3) LC-50 __________ (ppm/hr)
- Ingestion hazard (Yes or No) LD-50 __________ mg/kg
- Skin and eye contact hazard (Yes or No)
- Carcinogen (Yes or No) Teratogen (Yes or No) Mutagen (Yes or No)

Fire and Explosion Hazard
- Fire hazard (Yes or No) Toxic by products (Yes or No)
- Flash point _______________ Autoignition temp. _________
- UEL __________ (%) LEL __________ (%)

Reactivity, Corrosivity and Radioactivity
- Reactive (Yes or No) with water (Yes or No) with air (Yes or No)
- Corrosive (Yes or No) Acidic (pH) _______ Basic (pH) _________
- Radioactive (Yes or No) Background, Alpha particle, Beta particles, Gamma radiation

Personal Protective Equipment Needed
- Respirator (Yes or No) What type? _______________
- Gloves (Yes or No) What type? _______________
- Glasses (Yes or No) What type? _______________
- Recommended Level ____________

Sources of Information

1) ______________________ 2) _______________________ 3) ______________________

Attachment #2 - Incident Hazard Risk Assessment Data Sheet

Quantity and Toxicity of Materials
What are the material health hazards? ______________________________
What chemical quantities are involved? ______________________________
Is there a potential for fire or explosion? ______________________________
What personal protective equipment (PPE) is needed? ______________________________

Potential Exposure to People, Property and the Environment
Are there any victims? ______________________________
Any other potential human exposure, who is at risk? ______________________________
Is there adequate ventilation? (Yes /No) ______________________________
Will the area become a **confined space hazard** due to
limited access ______________________________
insufficient ventilation ______________________________
excessive toxicity ______________________________
explosive or combustible fumes and vapors? ______________________________
Event timing concerns ______________________________
Is employee evacuation necessary? ______________________________
Releases to environment (Yes / No) ______________________________
What environmental threats? ______________________________

Size, Type, and Condition of Container
Is the container rusted or corroded? ______________________________
Has the container been punctured or torn? ______________________________
Is the container leaking? ______________________________
Is the container bulging or dented? ______________________________
Is the container potentially exposed to flame or heat? ______________________________

Levels of Resources Needed and Available
Is monitoring or sampling required ? ______________________________
Is there a need for further resources? ______________________________
Is notification required ? ______________________________
What resources (human and equipment) are required and are readily available? ______________________________
What can be done immediately? ______________________________
- Is diking necessary? ______________________________
- What containment equipment is readily available? ______________________________

Weather Conditions and the Site Terrain
What are the weather conditions? ______________________________
Is it raining or is it a hot, dry day? ______________________________
What is the topography. Is it flat, are there hills? ______________________________
Will the topography affect the approach considerations or evacuation considerations? ________
What is the terrain like? ______________________________

Attachment #3 - Containment and Control Options and Objectives Sheet

Action Options	Ideas and Actions
1. No Hazardous Intervention	Operational Level Responders who have a positive safety attitude will understand that this is frequently the best option. Do you know the chemical hazards involved? Is the situation extremely dangerous? Do you have the proper Personal Protective Equipment? Is it best to simply isolate the area and deny entry or prevent access?
2. Hazard Containment	- Is diking or damming an option to control or confine a liquid? - Should you use material to cover a floor drains and man holes? - Should you retain or hold back, hold secure or intact (in natural low area)? - Should you divert and turn the spill aside to change the spills course?
3. Hazard Control and Clean-Up	- Is upright the container a safe option? - Can you roll a punctured drum over so that the hole is upward? - Will shutting off valves control the source? - Will dispersing and spreading the hazard be helpful? - Can you safely plug the leak with hazardous response equipment? - Should you dilute and diminish the chemical strength of the substance? - Should you absorb the materials to clean-up the spill?
4. Hazard Confinement and Evacuation	Should the area be evacuated? To what extent? What are the evacuation options? Should the spill area be confined? Should air quality confinement or ventilation be initiated? Where should control zones be set up? 1) Exclusion Zone (Hot Zone or Inner Perimeter) 2) Contamination Reduction Zone (Warm Zone or Secondary Perimeter) 3) Support Zone (Cold Zone or Outer Perimeter)

Objectives and Methods For Control of the Hazardous Incident:

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Session 15. Spill Control In The Shipyard

Offensive control and containment options are reserved for the HazMat Technician due to their specialized training and experience. The HazMat Technician may be called upon to decide which chemical protective equipment is best to protect the entry responders. Understanding containment and confinement controls and safe work practices, during an incident will help the HazMat Technician make these critical decisions. Careful planning is the key to safely and effectively containing any release. Hazardous materials spills/releases should be contained as quickly as possible to eliminate or reduce the hazard, prevent contamination of people and the environment and to facilitate cleanup. Throughout this session, the word “spill” is used to indicate that a hazardous substance has left its container or area of use.

Types of Spills

Spills can occur in many forms and many ways. Some examples are as follows:

- Over-turned containers
- Leaking (worn-out, punctured or breached) containers
- Intentional dumping on the ground, into waters or into drains
- Uncontrolled and runaway reactions
- Sample container leaks
- Leaking gas cylinders or lines
- Leaking gas and/or oil tanks

Goals and Objectives of Spill Control

The goal of spill control is to prevent or at least to minimize environmental damage and personal exposure to hazardous materials resulting from a release of a hazardous substance. Preventing environmental damage and personal exposure is more important than preventing property damage. The first objective is to prevent a hazardous substance from escaping from a damaged container. To stop or slow the flow of the material from its original container, is frequently referred to as "containment." The second objective is to control a hazardous material that has already been spilled, or otherwise released from its container. This is sometimes referred to as confinement.

Throughout this session, confinement and containment will be used as interchangeable ideas with respect to spill control. As a central goal, it must be realized that improper response actions, regardless of good intentions, can risk the lives and health of many people and cause permanent environmental damage.

Planning Is The Key to Control

In shipyards where the chemicals on-site are known and identified, the process of containment and control is most efficient with proper planning and preparedness. This includes:

1. Knowing which containment or control method is compatible with each chemical capable of spilling in all areas of the shipyard.
2. Having adequate supplies available to manage all potential spill emergencies.
3. Establishing policies and procedures for responding to incidents of each chemical, at each location, throughout the shipyard, based on a variety of specific spill sizes and other incident characteristics.
4. Training and exercising emergency response personnel to several potential situations

Considerations During Spills

The followings factors should be considered in a spill situation:

- Spill risk assessment
- Hazards associated with the materials
- State of the materials (Solid-Liquid-Gas)
- Quantity of materials
- Company policies (What constitutes a small or large spill?)
- Equipment needs (Do you have what you need ?)
- Route of dispersion
- Secondary contamination potential
- Weather

Steps In Spill Response

1. **Identify** the material and its associated hazards (chemical hazard assessment)
2. Use **proper** protective clothing and **equipment**
3. Spill risk **assess**ment
4. **Stop** the flow at the source (plugging, patching, uprighting)
5. **Confine** spilled material to the immediate area (dams, dikes, absorbent)
6. **Recover** spilled material and dispose properly

Spill Control Safety Precautions - Leaking Drum

Regardless of how a leaking drum is handled, there are few safety precautions that emergency response personnel must follow when containing a spill:

- The scene must be evaluated for potential hazard prior to taking any action.
- Appropriate safety precautions and personnel protective equipment must be used to safeguard response personnel.
- The drum should be visually inspected for signs of damage that would impact how the leak is controlled.
- The risk of sudden catastrophic failure if the drum is moved must be evaluated.
- The buddy system must be used any time it is necessary to lift or move a heavy drum and when respirators are require.

Control is Equal to Containment Plus Confinement

The defensive or offensive procedures, techniques and methods used in the mitigation of a hazardous materials incident includes containment and confinement. As mentioned above, containment is generally defined as those actions taken to keep a material in it's container (i.e., stop a release of the material or reduce the amount being released).

Containment includes:

- Plugging Leaks
- Patching holes, rips or breaches
- Overpacking
- By-passing

Factors that make containment difficult are:

- The nature of the hazardous material
- The condition of the original containers

- The extent of the spill
- Other hazards present in the area
- Geographic and weather conditions
- The time of day
- Lack of proper training or equipment

The Role of the HazMat Technician Responder

The HazMat Technician must be able to anticipate:

- The amount of materials that will eventually be spilled or leaked during the course of the incident
- The area that will be impacted
- How long the spill or leak will continue if uninterrupted
- How large of an area must be prepared to contain the material
- What additional measures are required where weather or topography make containment difficult

Confinement is the other term that has been previously described. It is used for controlling spills and is generally defined as those procedures taken to keep a material in a defined area once a release has occurred. Confinement operations include the following:

Secondary Containment	Retaining	Foaming
Overpacking	Isolating	Plug and Patch
Diking	Dispersing	Absorb/Adsorb
Damming	Transfer	Diverting
Covering	Containerize	

Spill Risk Assessment

Chemical hazard assessments are discussed in previous modules and this information must be taken into account when considering control options. For the Spill Risk Assessment, there are three questions that must be asked:

1. What will happen to the spilled substance if we do nothing?
2. What will happen if responders where to plug or patch to control the release?
3. What will happen if we just keep the material from spreading ?

Based on these questions, the responder can act according to their level of training and within their capabilities and resources to control the release.

The First Responder will do all of the above and more, provided they have the appropriate protective equipment and spill control supplies. Think Safety, Isolate and Deny Entry, Notify Authorities and make an attempt to contain and control the spill at the source.

Note: The technician has a great deal of knowledge about containment and control. However, knowledge alone, will not protect from the hazards of a chemical. ***The HazMat Technician becomes a First Responder at the Awareness level when there is no equipment available.***

As in any activity that involves decision making, spill control measures are only as good as the information on which decisions are based. Therefore, it is crucial that a chemical hazard and spill assessment are thorough. In most cases, a fairly standard set of questions need to be answered carefully, with an awareness for unexpected problems. The first concern is always for human life, including the lives of the HazMat Responder.

Some important incident assessment considerations are as follows:

- Injuries or imminent hazards (is immediate action necessary?)
- Identity of substances
- Hazards of substances
- State (solid, liquid, gas)
- Surroundings (inside, outside, nearby equipment)
- Size or flow rate of leak(s)
- Volume of containers
- Leak ongoing or stopped (situation worsening or stable)
- Chemical reactions
- Current routes of dispersion
- Likely routes of dispersion
- Threatened resources (people, waterways)
- Opportunities for control/containment measures (conversely, conditions prohibiting such measures)

Following the spill assessment, the next step is to analyze the available information and establish a plan of action. Immediate action is not always necessary or desirable. Furthermore, in some cases the most appropriate action, following assessment, may be to retreat. Do not hesitate to be prudent.

Below is a rough list of priorities to use as a guideline when managing a spill:

- **No action** may be a valid course of action for the HazMat Technician
- **Life safety** is the foremost priority. All actions must consider employee health and safety
- **Protection of the Environment,** from spill runoff
- **Protection of property.** How soon can the area return to normal operations? Business recovery.

If control measures are to be initiated, the following list of concerns must be addressed:

- Will the technique work for this spill?
- Is control possible and safe?
- Is the required equipment on hand?
- Will any likely conditions make the method fail? (rain, wind, incompatibility, container movement, open sewer lines)
- How quickly will the method fail? (corrosion, permeation, overflow)

Control an Containment Methods

It is important that each HazMat Responder must be familiar with the specific instructions for all equipment to be used. Several proven techniques will be considered. In all cases, it is assumed that a sufficient incident assessment has been performed and that the control methods can be employed safely.

Close The Container

Frequently, containers are leaking from a point at which they normally dispense the material. If this is the case, make an attempt to close the container and stop or slow the source. This process may include tightening bungs with a non-sparking bung wrenches.

Pressure vessels may leak at the valve or valve assembly. Tightening the valve may stop or slow the leak. If not, quickly open the valve enough to create a sharp burst of gas release, then tighten. This may dislodge any scale, or ice, blocking the valve.

Repositioning The Container

If the container has one leak, or several in the same area, the flow may be slowed or stopped by positioning the container with the leaks on the upper surface. If the container holds a compressed gas this method is of no value. But for containers of liquid this technique will greatly decrease the amount of liquid escaping and facilitate subsequent actions, such as transferring or patching. The steps are as follows:

- Roll container to position the leak(s) above liquid level.
- Wedge the container solidly in pace so that it will not shift if its center of gravity changes.

The potential difficulties associated with this technique are excessive weight of the container and it's contents. Full 55 gallon drums may weigh in excess of 400 pounds and present a safety hazard to HazMat Technician Responders.

Plugging, Patching and Catching

There is less of a hazard to both personnel and the environment once a leak is stopped because all operations can be carried out more safely. Catching is the process of utilizing some capturing device to collect and contain a leak. Stopping the leak by plugging or patching helps to keep the incident from escalating. Plugging devices work in one of three ways:

Friction These are devices that are wedged into the hole to create a seal. Examples include wood or neoprene plugs and wedges, threaded and tapered boiler plugs, sheet metal screws with rubber grommets and small lag bolts.

Expansion These are devices that are inserted into the hole, then expanded to seal the hole. They consist of rubber balls, tapered rubber test plugs or rubber caps. They typically have a threaded rod down the middle, with a "butterfly" nut on one end, that is inserted into the tank through the puncture or hole.

Compression These devices are applied around the container or pipe, then cinched down. They can consist of very simple muffler clamps, with a rubber seal, or, they can be very expensive and intricately made pipe clamps.

Patching involves placing something that will stick or adhere to the outer surface of the container. The patching material is usually a chemical substance. Use of "adhesion" type patching materials is not advisable on pressurized cylinders or liquid containers if the "head pressure" of the liquid is eight (8) pounds or more. There are many categories of patching materials:

- Epoxies. These may be mixable on site or pre-mixed.
- Rubber compounds such as swelled neoprene rubber, butyl rubber sealer or polysulfide rubber.
- Foams or plastics such as polystyrene, polyacetate or polyurethane.
- Fiberglass mastics
- Commercial substances such as Plug "N" Dike, Aqua Seal or silica gel.

Catching is a means of capturing or containing the leaking product. It can be done prior to plugging or patching, or may be done as a supplemental measure if plugging or patching is not successful. Large plastic buckets or pails are best because they are compatible with various chemicals and have a higher resistance to degradation. Metal containers are often unsatisfactory because metal can be highly reactive with acids, alkalis, oxidizing agents and peroxides.

Containers used for catching operations should be specifically designed (a bucket type is recommended) and purchased for that purpose. Containers that are appropriated at the scene may be the wrong type, or they may be dirty and contaminated. They also may not be legal for the specific substance.

There are a wide variety of plugging, patching and catching devices and techniques available. The following general procedure applies to most of these methods:

- Position leak(s) in vapor phase if possible
- Clean leak area of excess fluids, scale and/or dirt
- Apply plugging or patching device

Always remember that no repair will make the container as effective as if it was in it's original state. Repairs are temporary measures. The substance must be repackaged prior to moving.

The repair material or catching container may be incompatible with the leaking substance. Incompatibility reactions can result in heat generation, fire, evolution of gases and deterioration or greater fatigue of the container. The most effective method of handling incompatibility problems through preventative measures. Know the substance and its properties prior to application of the plug or patch. This is a function of the emergency planning.

Other plugging and patching materials can be used to temporarily stop leaks in drums and tanks. Commercially available items include:

Self-tapping screws with compression seals
Cork plugs
Closed cell polyurethane sheeting
Bolts with various compression fittings
Vetter bags
Tubeless tire repair kit
Pipe plugs

Wooden plugs with felt covering
Neoprene plugs
Urethane foam kits
Epoxy putty
Band-Aid patch,
Lead wool

Containment Technique	Appropriate Situation	Pro	Con
Closed Container	Leaks at bungs, valves and closures	Easy, fast	Close proximity to vessel
Reposition Container	Movable container of liquid with single leak, or several in the same area	Fast	Lifting hazard
Wooden Plug	Non-pressurized container with irregular shaped hole	Simple, fast, swells to seal hole	Incompatible with corrosive
Sheet Metal Screw	Non-pressurized container with small hole	Effective seal on soft, thin metals	Ineffective on thick, hard metals

Bolt (T and Toggle)	Non-pressurized container with irregular shaped hole	May seal very irregular opening	Time consuming, more parts
Pressure Patches (Vetter bags, Band-Aid)	Large leaks in large vessels	May seal large leaks	Complicated, expensive
Epoxy Putty	Non-pressurized container with thin or small crack	Effective on cracks	Requires curing time
Silicone Sealer	Non-pressurized container with leak in weakened wall	Minimal stress on container wall	Requires some vessel pressure
Chlorine Kit	Pressure vessel leaks at valve and stem area or container sides	Best method for pressure vessels	Complex, expensive

Plugging and Patching Equipment: (Be Prepared To Use It!)

Plugging and patching equipment is limited by budget, space available on response rigs and the imagination of response team members. Much of what is commercially available today is the direct result of creative improvisation by response personnel at the scene of an emergency. Response teams may opt to purchase "pre-made specialty kits," or design their own kits.

Tools On-Hand: A variety of hand tools are needed for plugging and patching operations. Tools should be available in a variety of sizes. Recommended tools include, but are not limited to, screwdrivers, hammers, pliers, socket sets, wrenches, cutting tools, punches, chisels and prying tools. A selection of non-sparking tools should be available for work in potentially explosive atmospheres.

Plugs and Wedges: A variety of wedges and plugs made of wood or neoprene should be included in the kit. Neoprene wedges are generally easier to use than wood and are compatible with more chemicals. Other hardware may include self-tapping screws, boiler plugs, pipe plugs and caps, pipe clamps and bandages, neoprene sheets and pads, tubeless tire repair kits, pop rivet tools, "T" bolt patches and toggle bolt patches.

Epoxies: Various epoxies and putties should also be part of a plugging and patching kit. Examples include Devcon 5 Minute Epoxy, Seagoing Poxy Quick, Plug ‘N’ Dike, Aqua Seal Ltd. and Petroseal. Each of these is discussed in more detail in the Information Sheet later in this chapter.

Pneumatic Patches: Pneumatic patches may also be used to stop a leak. Pneumatic patches may be in the form of air bags, leak sealing bags, pipe plugs or leak sealing bandages. They may come in a variety of sizes. They may be inflated by compressed air tanks or manually with pumps. Response personnel must be careful not to over inflate these devices so the pneumatic patch is not damaged and the leaking container does not collapse. Neoprene pads should be used to protect the patches from damage caused by hot or sharp surfaces.

Pressurized Container Plug and Patch Techniques

Plugging or patching pressurized containers presents a special set of challenges. In addition to the intrinsic hazards of the leaking substance, the vessel or pipe may rupture violently. Pressurized leaks are more difficult to stop, due to the internal pressure of the container.

Most leakage from pressurized cylinders occurs at the stem and valve area. Therefore, control activities are directed towards blanking, blocking or capping the valve system. Commercial chlorine emergency kits are available for use on pressurized containers. They operate on the principles of capping off the leaking valve or blocking the stem with plugs. These kits come complete with detailed instructions and all necessary tools. Although all pressurized cylinders do not contain chlorine, most of the 100 to 200 pound cylinders have comparable fittings to allow their use with other gases.

Pin hole leaks in the walls of pressurized cylinders can sometimes be stopped with the use of patches. Chlorine emergency kits have patches included. These patches may be utilized for small leaks in the sides of the cylinder. Prior to use, the HazMat Technician must have detailed instructions and practice that will enable him/her to be proficient in handling pressurized cylinder leaks and using the emergency response kits.

Transferring Hazardous Substances During Spills

Transferring occurs when a substance is pumped from the damaged container into another container. The utilization of transferring, as a control method for incidents involving 5 gallons or less, is usually not considered a viable option due to set-up time and limited volumes.

The most common difficulty encountered when transferring is pump failure caused by incompatibility reactions. Anytime a substance is being transferred, the compatibility of that substance with the internal components of the pump, fittings and the hosing must be addressed. Prior to purchasing pumps, the response plan should identify the possibility of incompatibility reactions with different pumps.

Another difficulty arises when transferring flammable or combustible liquids. The motion of the liquid generates static electricity, which may cause sparks, setting off the flammable atmosphere inside or outside the container. To prevent this it is essential to:

- Bond the two containers together, starting with the leaker.
- Ground the receiving container to something in intimate contact with the earth. Standard procedure is to connect the container to a steel rod driven several feet into the soil.
- Always use non-sparking pumps when transferring flammable and combustible materials

Overpacking Containers

Overpacking involves the placement of the leaking or damaged container into another larger container. For example, a damaged 55 gallons drum is commonly overpacked in an 85 gallon salvage drum. The overpacked substances can be repackaged, transferred for recovery or use, or transported for disposal.

"Overpacking" involves placing the damaged drum inside a larger container. Overpacking is a method commonly used to handle leaking containers, particularly when drums are very heavy and require a forklift or special drum lifting apparatus to maneuver.

The scene must first be prepared for the overpacking operation. The overpack (receiving) drum should be placed close to the target drum to minimize movement. If necessary, a heavy plastic sheet should be put under the work area first and drums moved into position on the plastic. Lids or bung hole caps must be completely tight.

Additional preparations should be taken when the damaged drum contains a liquid. Special plastic liners should be used in the overpack drums. If possible, the liquid in the damaged drum should be off-loaded by pumping into a good drum. The pump must be compatible with the chemical and both the drums and the pump should be grounded and bonded. Adequate diking should be prepared ahead of time. The three methods of placing the target drum into the overpack drum are outline below.

Method 1:

1. Lay the salvage drum on it's side next to the damaged or leaking container.
2. Lay the leaking drum on it's side and insert into the salvage drum.
3. Push the leaking drum completely into the salvage drum. Use a large plastic drum liner to facilitate the placement of the leaker.
4. Upright the overpack drum and seal.

Method 2:

1. Place the salvage drum down over the top of the leaking container.
2. Lay the overpack-on its side.
3. Upright the drums and seal. EPA regulations require that the inside container's closure must be right side up for land disposal.

Method 3:

For more controlled situations where facilities and equipment are accessible, a remote mechanical device such as a drum sling, drum grappler or drum fork can be used to place damaged drums into salvage drums. These types of equipment are usually large, heavy and expensive.

Cooling Substances for Control

Pressurized cylinders can be cooled with cold water to reduce their temperature. This decreases the temperature and vapor pressure to slow the release. This method will work with small leaks in the upper portion of a cylinder where liquid level will fall below the leak. Before this method is utilized, the characteristics of the substance must be known. Some substances, such as chlorine, when released into water, will increase the corrosion rate of the container, thereby increasing the size of the leak. Water may also warm the substance instead of cooling it, depending on the water temperature. Warming a substance increases the vapor pressure, which increases the amount of gas released.

Cryogenics are used to cool the substance in the container, or to create a seal by freezing a liquid soaked patch into the leak or around the stem and valve area. Although this technique has been successful, it has several major problems. First, cryogenics in and of themselves are very hazardous to work with. Experienced handlers are necessary. Second, the cryogen must be periodically reapplied due to rapid evaporation. Both of these processes have the potential to create oxygen deficient atmospheres as most cryogens are asphyxiants. Care must be taken to continuously monitor the atmosphere for oxygen content.

Sorbents Used For Control and Containment

The purpose of sorbents is to stop the flow of spilled substances by adsorbing or absorbing. A wide array of sorbents are available, from ordinary straw to complex synthetic products. Sorbents are applied on or in the path of spilled substances. Once the sorbent is saturated, it is removed and placed in a suitable container. If any substance remains, fresh sorbent is applied. This technique

works only as long as sorbents come in direct contact with the spill. "Absorption" refers to a technique that utilizes any solid capable of absorbing a liquid several times its own weight and mass.

The following must be considered prior to the using sorbents:

- The sorbent must be compatible with the spilled substance.
- The sorbent will become contaminated with chemicals and will have to be transported to the disposal site.
- Contaminated sorbent materials possess all of the hazards of the chemicals they have absorbed: (flammability, toxicity, reactivity, etc.)
- Sorbent materials can be natural or made of synthetic materials

Using Absorbent Materials: Absorbent materials may be used to absorb or collect a liquid. There are several types of absorbent materials available, each designed for different applications.

- Pads consist of a soft sheet or cushion of special material having exceptional absorption qualities. Pads are generally designed to absorb specific materials.
- Socks consist of a long tube of soft, porous, cloth filled with absorbent material. The average size is 6 to 8 inches in diameter and about 3 to 5 feet in length. They are very soft and pliable, bending into any shape desired. They can be used to dike or contain liquid spills of low depth.
- Pillows are made of the same materials as the socks, but are shaped like pillows instead.
- Bulk application products such as diatomaceous earth, vermiculite, kitty litter, dolomite, sand, dirt or sawdust.

Absorbent materials are safe and easy to use. However, there can be several disadvantages that response personnel must take into consideration when choosing an absorbent material:

- Absorbent materials work best in calm environments. Winds will stir bulk product. Choppy or agitated waters will affect the efficiency of absorbent pads.
- Heavy oils are often not efficiently absorbed. They require other methods of pickup.
- Absorbing materials sometimes require methods of flotation to prevent sinking when they are saturated with water or water soluble liquids.
- Care must be taken in removing saturated pads, socks and bulk substances to avoid contaminating other surrounding areas.
- Diatomaceous earth and certain silica gels may require disposal in a Class I dump.
- Absorbent materials should be selected based on compatibility with the specific chemical. The use of an inappropriate absorbent material may make the incident worse.
- Appropriate personal protective equipment and proper tools should be used when applying the absorbent materials.
- Once the spill is absorbed, the absorbent material and the liquid should be carefully packed. In most cases, packaged absorbents will need to be disposed as hazardous waste.

Drain Covering For Containment

Drain covering prevents the spill from being dispersed through the sewer or storm drain system and it can temporarily store the spill in the depression surrounding the drain. Drains can be covered with flexible material, such as poly-sheeting, while a rigid cover, such as plywood or sheet metal, is required for larger openings. Once in place, the cover must be anchored to prevent it from being

dislodged. Sand, bricks, blocks, steel bars and other available materials adequate for weighing down covers.

Drains should be covered before the spill trail arrives. However, covering can be accomplished afterward if the personnel involved are adequately protected for direct contact with the material. For example the cover (a polyethylene sheeting under plywood), can be held over the drain and lowered evenly. Then, if necessary it can be pushed through the liquid and held down on the drain with weights.

Creating Dams for Spill Control

A dam is a man-made barrier constructed to contain liquid contaminants. They often take advantage of barriers that exist in the shipyard such as levees, berms, curbs, walls, building, gullies and culverts. Dams are good for controlling water run-off at large fires and hazardous materials incidents and controlling contaminants to prevent pollution of waterways. However, dams are often time consuming to build properly. If they are not constructed high enough, wide enough, fast enough, with the appropriate materials, they may fail to contain the contaminant. Heavy rains can reduce the effectiveness of a dam.

There are two types of dams: simple and complex. A simple dam is constructed of earth, sand or sandbags. The can be constructed rapidly if sufficient materials are available on scene. Simple dams may be used as an intermediate measure to "buy time" for emergency responders until advanced containment and clean-up measures can be implemented. Plastic sheets or bags can be used in the construction of these dams to add strength and integrity while reducing erosion and seepage.

Complex dams, sometimes called "separation dams," are designed to separate the contaminants from the water. They are best utilized for recovery of the product, as well as to prevent overflow and further spread of contamination. There are two types of separation dams: overflow and underflow. Overflow dams are used when the contaminant is heavier than water. Uncontaminated water flows over the top or through a pipe close to the top. This type of dam is relatively quick to construct.

Underflow separation dams are used when the contaminant is lighter than water and will float on top. A pipe is installed through the earthen berm, allowing uncontaminated water to pass through the dam, under the contaminant. This is more complex to construct than an overflow dam.

Diking Spill Control

Diking stops or changes the flow of liquid substances with strategically placed barriers. Barriers to flowing substances can be constructed of available soil or commercial materials such as polyurethane foam or foamed concrete. Even a fire hose filled with water can act as a dike. Try to avoid digging holes or trenches in the path of the liquid to contain or direct it. This tends to increase the rate of soil permeation and groundwater contamination. Basic design considerations are similar in each case. Barriers must be massive enough to withstand the pressure exerted by the flowing or contained liquid. This consideration increases in importance with increased spill quantity. Barrier operations are most appropriate where drainage patterns are pronounced and the width to be covered is minimal.

A variety of materials can be used for diking purposes. Dirt, sand, sawdust and absorbent materials such as pads, pigs, booms, pillows and bulk absorbents are usually readily accessible. Polyurethane foams are another option. They are commercially available in pressurized containers ranging from small aerosol cans to large 1, 2 and 5-gallon pressure vessels. Polyurethane foams

can be applied quickly. They usually swell up into tremendous volumes during application and can be formed or shaped into any size dike. They may also be added to and built up as needed. With the exception of some chemicals, such as aldehydes and some solvents, polyurethane foam does a good job of resisting breakdown.

Dam and Dike Construction

A site should be selected far enough downstream to allow time for construction. This is very important for successful containment and for the safety of those building the dam or dike. Response personnel should choose a site based on the best option available. They should always take advantage of natural surroundings. An area where two opposing banks are rather close together will reduce the amount of fill needed to complete the dam The wider and deeper the area in front of the dam (the side where the contaminant is located), the more it will collect and contain.

As workers begin filling in the area between the two banks, start from both sides and work towards the middle. A sheet of plastic should be placed on the inside of the dam to add strength and prevent erosion or seepage. The plastic should start a few feet past the lowest point of the dam and continue over the top. It should be weighted down so it will not move.

Diking and Damming Considerations

There are several factors that should be considered before making a final decision about diking and damming to control a spill. Several of the considerations are listed in the table below:

Consideration	
Amount of Fluid	Most hazardous materials emergencies involve leaks from small five gallon containers, 55 gallon drums, or tankers ranging in size up to 9,000 gallons. Usually with any of these quantities, diking is the most appropriate method of containment.
Rate of Fluid Leak	Response personnel must consider if they can construct an adequate dike given the rate at which the liquid is flowing. Can the dike contain a large leak over an extended period of time? The rate of the leak will dictate how large the dike must be.
Chemical Hazards	What is the health hazard associated with the chemical? Is there a danger of ignition? Can a dike be constructed safely, given the hazard? If there is more than one chemical leaking, such as from multiple containers that have been damaged, response personnel must construct dikes that will keep the materials from coming in contact with each other. Even chemicals which are not normally considered to be incompatible should be kept separate to avoid creating an unknown substance.
Suitability of Diking Material	The diking material must be compatible with all the leaking substance. Dry dirt and sand are excellent under most conditions. However, hydrofluoric acid will react with sand. Special diking materials carried by many Shipyard HazMat Responders can be deployed quickly. Examples include absorbent socks, pigs, booms and blankets, bags of diatomaceous earth or vermiculite, or containers of Plug N' Dike material.
Availability of Diking Material	Small leaks can generally be managed with the supplies found on scene or carried on the response vehicle. Even the contents of a dry chemical, extinguisher can be used in a pinch, if it is compatible with the spilled material. If the leak is large, additional diking materials should be requested as soon as possible. It can take time to locate supplies, transport vehicles and drivers, especially after hours or on weekends and holidays. Additional

	delays may be caused by rush hour traffic or road closures. It's important that response agencies have plans in place for the emergency acquisition of diking materials and that those plans address such contingencies.
Personnel and Equipment Required for Diking:	A small leak from a 55 gallon drum can be diked easily by a handful of people in just a few minutes. Larger leaks require additional personnel and larger equipment for construction material placement.

Other Containment Measures

A number of other measures may be used for containment. They include:

- **Weirs.** Construction of a dam to prevent a floating insoluble substance from going downstream, while allowing a large flow of water to continue underneath.
- **Oil Control Booms.** Construction of floating barriers to contain or divert an insoluble floating substance.
- **Skimmers.** Collection of an insoluble floating substance by suction devices from a vacuum truck.
- **Pneumatic Barriers.** Application of a screen of air bubbles to act as a barrier to insoluble floating substances.
- **Spill Herding:** The use of high-pressure fire hoses to herd or move the insoluble contaminant floating on the surface into a confined collection area. (This is another form of skimming.)
- **Dredging:** Removal of sediment and heavier-than-water contaminants from the bottom.
- **Encapsulation:** Covering the contaminant either with a plastic sheet, or a chemical substance to initiate jelling and solidification of the liquid.
- **Burning:** Intentionally burning flammable liquid floating on the surface.
- **Nets:** Encircling a floating contaminant with nets to contain and collect it.
- **Precipitation:** Application of other chemicals which will cause a reaction that forms a precipitate (solid) that will settle on the bottom for collection at a later time.
- **Biodegradation:** Application of microbes to take up and digest the contaminant in place.

Taking Samples for Abandoned or Incorrectly Labeled Drums

Hazardous materials incidents can involve abandoned drums or drums that are unlabeled or incorrectly labeled. This presents additional complications for response personnel. First, careful sampling must be performed to determine the contents of the drum. Response personnel should never just take someone's word for it. Correct handling procedures can only be determined once the hazard of the chemical are known. Second, it is often necessary to determine who has authority and jurisdiction over the substance (department responsibility) and who will absorb the cost of sample testing and drum removal. The following are some of the guidelines that should be used when taking samples:

1. Proper personal protective equipment must be worn during the process to protect personnel from potential hazard.
2. The sample should be placed in a small glass beaker or jar. (Plastic containers may be used if they are compatible with the product being sampled.) If the sample might be used as evidence in court, the sample jar must be certified "clean" prior to use.

3. Samples should be taken carefully to avoid contamination. Samples may be taken directly from the leak, from within the container, or from pooled product around the container depending on the circumstances. The sample jar should be carefully sealed.
4. The sample jar and leaking container should be labeled in indelible ink or with a marking pen. The sample jar number and incident number should be recorded on the jar itself. and written on the leaking container.
5. A log should be prepared to record the incident number, date, sample jar number(s), the name of the chemical (if known) or the word "Unknown", the name of the agency taking the sample, as well as the name of the person taking the sample.
6. The sample jar should placed into a heavy duty "zip lock" type bag. It should then be bagged a second time.
7. pH paper is used to test the corrosivity of a product. Personnel must be wearing appropriate protective clothing prior to testing any suspected corrosive. Long, stainless steel forceps should be used to handle the pH paper in order to prevent contact with the liquid. The pH paper should first be activated with distilled water. After it is dipped into a sample of the product it should be placed on a piece of cloth or paper towel. Color changes should be compared with the color guide supplied on the pH paper container.

Bulging and Leaking Drums in the Shipyard

Is the drum bulging?
This could be due to a previous exposure to heat or fire. If the drum is closed, the bulging indicates tremendous pressure inside. The drum is now a ticking time bomb. Tampering with the bung cap could be very dangerous as the products inside are under tremendous pressure. If this drum must be opened a remote opening device should be used. All responders should stay a safe distance away while the pressure is relieved.

Bulging may be caused by two incompatible materials or wastes combining, causing heat and pressure during this chemical reaction. The new compound formed is a complete unknown. Drums may also be deformed due to impact and collision from an accident.

Is the drum leaking?
Wet spots on the ground next to a drum are usually evidence that the drum is leaking or has leaked. If the drum is leaking, response personnel should look for clues that will help determine what action is necessary:

- How much product remains in the leaking container?
- What material and hazards are present?
- What direction is the product traveling?
- Is diking necessary?
- Is this a current leak or an old leak? Coagulation on the ground, rust or corrosion around the base of the drum, stain marks on the pavement or concrete and deterioration of the asphalt around the drums are all signs of an old leak.

Case Example

This example is certainly not the only way to handle an incident and any variation in the situation might call for a totally different approach.

The HazMat Technician Responder was called to the parking lot behind the loading dock. The call stated that a strong-smelling liquid was leaking from the back of a box trailer. The truck driver had entered the trailer and become dizzy but had escaped unharmed.

Assessment	• "Solvent" smell was detectable at 70 yards • No acute injuries or obvious imminent hazards (driver recovered, truck in open, well ventilated area) • Substance identified as paint drying agent in 55 gallon container • Phone call to manufacturer indicated major ingredient was MEK, which is flammable and is toxic by inhalation • The leaking material was liquid and clearly had a high vapor pressure due to presence of concentrated vapors • Trailer contained approximately 50 drums and the number leaking was not known • No liquid was flowing from the trailer • Measurement with combustible gas indicator showed less than 2 percent of the LEL in the trailer
Select & Prioritize Actions	• Concluded that one or more drums had small, slow leak(s) • Concluded that explosive risk was minimal • Concluded hazard to be potentially serious and opted to use PVC suits, gloves and SCBA • Opted to find leaker(s) and overpack in 85 gallon salvage drum(s)
Actions	• Donned protective clothing • Examined drums and found one leaker • Placed leaker in salvage drum • No further clean-up was executed because leaked substance had vaporized • Trailer doors were left open to allow complete dispersion of vapors

Mitigation at an industrial facility by means of offensive control options is reserved for the HazMat Technician. This is because special training and protective equipment is required to safely and effectively handle the incident. Repositioning and overpacking drums are common procedures. Other options include plugging, patching and catching. A variety of Materials and equipment is available for this purpose. Emergency Response Teams may purchase commercially available kits or develop their own.

Although defensive control options are generally considered to be something that can be handled by the First Responder - Operational Level, they will most likely require the expertise and supervision of a HazMat Technician. Knowing how a product will behave and being familiar with the various defensive control options, are essential in the decision-making process.

Session 16. Spill Response and Clean-Up Guide

The specific actions taken in response to a spill or release will vary because of the vast diversity of potential hazardous situations in shipyards. The hazards of the material, the location, the weather and the amount spilled substance involved will all affect the response scenario. The actions taken in response to a spill of trichloroethylene in water, for example, will be different than the response taken to collect a spill of oil in water. Similarly, the medium (air, surface water, soil, containment area) into which the release occurs also affects the required response. Due to the complexities surrounding the selection of a response procedure for specific emergency situations, this session will address a general clean-up response sequence that can be applied to shipyard hazardous substance spills.

Planning for Emergencies

When an emergency occurs, decisive actions must be taken quickly to limit the severity of the incident. Personnel and equipment must be readily available to respond in a moments notice. Only planning will ensure the effectiveness of response actions. Shipyards develop and implement emergency response plans, which are documents that detail the specific response actions, to be initiated in the event of a hazardous substance spill or emergency. Response plans require much time and effort to develop. The purpose of planning is to save valuable time when responding to an emergency. Developed under non-emergency conditions, these shipyard documents take into account all possible situations and response procedures employed during a response.

General Emergency Response Procedures

Upon discovery of a spill or fire situation, the initial examination will provide important information to responding personnel. Identification of what happened, where it happened, to whom it happened, when it happened, the extent of damage and what aid was needed must be included in the report to the incident communication system. Once response personnel receive this information, an evaluation will be made as to the proper response procedures. A good emergency response plan details response actions that are specific to the shipyard materials, equipment, facility layout and response personnel. The following outlined sections (A-F) provide the basis for emergency response planning:

A. Rescue: In the event of an emergency, rescue of injured personnel is one of the first priorities. Ensure that responders properly protect themselves. Unless you know the specific hazards, use at least EPA Level-B protective gear (including chemical resistance coveralls and SCBA). Remove victims from the immediate spill/fire area as soon as possible.

B. Alert: Notification of the emergency should be undertaken as outlined in the facility emergency contingency plan. In fire situations, this includes pulling the fire alarm or calling the fire department as soon as possible. In a spill, the procedure may also include notification of the fire department (if their responsibilities include spill response) or the on-site HazMat team.

C. Assessment: It is vital to determine what chemicals are present and their hazards in order to apply the appropriate levels of protection as well as address several other safety and emergency response concerns.

D. Contain: Immediate containment of a spill or fire is a high priority. Containment will minimize the exposure of personnel to dangerous materials or life threatening fires. Containment will also enhance the chances of recovering useable material and minimizing the total time and cost

associated with final clean-up. The specific circumstances and extent of an emergency will dictate the timing and response actions taken to contain a spill.

E. Evacuate: Evacuation is the removal of non-essential personnel from specified areas. Depending on the circumstances of the spill, release or fire evacuation may include the immediate vicinity, adjacent areas and buildings and off-site areas. The decision to evacuate is made by the Incident Commander. Upon announcement, personnel should immediately leave the area by the designated evacuation routes and meet at specific at points outside the affected area.

F. Cleanup: A wide variety of techniques are available and the choice will be dictated by the substance spilled as well as the containment techniques applied. Cleanup may require a combination of several different techniques. In addition to deciding what techniques are appropriate, cleanup personnel must determine when the cleanup process should begin and what level of cleanliness determines completion.

Immediate Actions

The immediate actions of all employees of any company or shipyard in the event of a chemical spill or gas release must be understood before an incident occurs. The immediate actions are:

1. Clear the area
2. Check for personal involved
3. Isolate the spill (if safe to do so)
4. Perform emergency response

The primary function any shipyards management and employees in all emergency response actions should be to protect the health and safety of all employees, contractors and visitors. No action should be taken during emergency response that directly or indirectly violates this principle. An evacuation of the building should be initiated if one of the following conditions occurs:

- **Uncontrolled Open Flame**
- **Uncontrolled Compressed Gas Release**
- **Any Situation That Poses Immediate Threat to Human Health or Safety**

When an evacuation alarm sounds all workers within the affected building(s) will immediately exit the building and report to their assigned evacuation stations. If a threat to their personal safety or well-being is perceived In the absence of such direction, employees are urged to leave the affected area of their own volition. Any attempt to stop or control the source of a release or eliminate potential sources of ignition shall be performed only if it can be accomplished without personal risk, during normal evacuation procedures.

Work area supervisors will verify the presence or accountability of all persons. All employees must remain outside the evacuated buildings until given further instructions. Evacuees are *not* to leave the shipyard grounds without authorization.

Releases to the Environment

Hazardous substance spills can be characterized in terms of the type of release to the environment. The following possibilities include: 1. Release to the land, 2. Release to air (material becomes airborne) and 3. Release into a body of water.

These releases are frequently interrelated. For instance, releases in air or on land can eventually end up in a body of water. A land release can contaminate ground water and subsequently migrate to a body of water. Releases to the air can fall back to the ground. The type of release is important because it helps determine the specific cleanup techniques or combination of techniques to be employed.

1. land Releases

Spills on land usually remain on top of the land until they are cleaned up or absorbed into the ground. Spills rarely permeate deep into the ground very quickly. The permeation rate and depth is dependent on the type of material (specifically, whether it is a liquid, sludge, or solid) and the porosity of the soil.

2. Air Releases

Air releases of gases or vapors can be very difficult to contain and/or control. Although, materials escaping inside a building may be partially contained by closing the doors and windows. In general, it is preferable to attempt to disperse a gas/vapor cloud with mechanical ventilation or knockdown misting. Vapor suppression methods such as the application of foam can be used to control vapor emissions from flammable liquids. Weather conditions such as humidity, temperature, wind speed and direction can greatly affect cloud formation and dispersion.

3. Water Releases

If the release does occur in a body of water, three possibilities exist depending on the material spilled:

1. the material is lighter than water and will float on top,
2. the material is heavier than water will sink to the bottom, and
3. the material is water soluble and will mix with the water to varying degrees.

Each of these three instances requires vastly different equipment and strategies for control and cleanup.

Hazardous Substance Spill Clean-Up Methods and Techniques

Very few general methods exist to clean-up spills in the shipyard. Once the safety of personnel near the spill has been addressed, the hard work of clean-up and decontamination must begin. Spills may be diluted, absorbed, and/or neutralized. The exact choice of procedures depends on the chemical toxicity, quantity involved, the spill location and what materials are immediately available. In this section, some technical information about the various spill response techniques and material types are discussed.

Sorption Of Chemical Spills On Land

The purpose of sorption is to convert a liquid spill into a solid form, which is easier to handle and pick-up. Dry sorbent materials are usually applied directly to the spilled substance. The saturated sorbent is then removed and properly contained. Open-top, liquid-tight containers that are compatible with the spilled substance must be used. For small spills, sorption may be the most appropriate technique because control and cleanup are combined. A critical requirement is that the sorbent be effective for the substance involved. Sorbents work only if they can be placed in direct contact with the spilled substance. Thus, sorbents cannot be used if the spill has entered the soil or sunk below a body of water.

Natural Sorbent Materials: Natural Sorbent Materials consist of dirt, sawdust, vermiculite and absorbent clay. Dirt is much more absorbent than sand. Sawdust can react with some materials but does not hold onto the absorbed material for very long. Vermiculite is extremely effective and is usually available in large quantities at places that supply materials for lightweight concrete, "cottage cheese ceilings," insulators, etc. Diatomaceous earth is also a good general sorbent and is available in large quantities from local suppliers. The key to obtaining resources, such as absorbent clay, is to identify local agencies and businesses that are accessible 24 hours a day, with the resource as normal "in-house" stock.

Synthetic Sorbant Materials: Many companies are now selling synthetic sorbent materials for hazardous material spill clean up. These materials are highly absorbent and specifically designed to clean up hazardous materials. These sorbents are made of a variety of materials including silicate particulate and polypropylene. They come in a wide variety of forms including mats, socks, booms, shreds and pillows. Understand that there is no standardized performance testing for these products so manufactures products will vary. Always check with the manufactures limitations for these products as some hazardous materials like sulfuric acid, fuming hydrofluoric or nitric acid may cause the absorbent to disintegrate. There are three basic categories of synthetic materials based on their intended use.

1. Oil skimming materials are those materials which are designed to clean or pick up petroleum products and hydrocarbons, yet repel water.

2. Non-aggressive absorbent materials or limited use materials are designed to pick up mild solvents, acids, bases and petroleum compounds. These materials will pick up water.

3. Sorbents designed for aggressive hazardous materials or universal sorbents are made of materials which are resistant to strong corrosives and solvents, as well as oils. These materials will absorb water based materials. For planning purposes, it is important to inventory chemical usage types and spill potential in order to appropriately select sorbent types. It may be necessary to maintain supplies of several different sorbent materials.

Advantages	Disadvantages
• May combine containment and cleanup • A layer of sorbent may decrease evaporation of the spilled substance (reduce air emissions) • Safe to use; sorbents are generally inert materials • Easy to use, rapid removal and requires minimal training and equipment	• Increased volume of substance that must be transported and disposed • May be expensive • Appropriate materials may not be readily available

Sorption In Water

The purpose of this technique is to remove floating substances from the surface of water. A dry sorbent is applied directly to the floating substances. The three most important properties of an appropriate sorbent are:

1. water repellency,
2. low density,
3. and ease of collection after becoming saturated.

A low density sorbent will float and will be easily retrieved. Skimming devices frequently use sorbant materials to remove contamination from water. The sorbent must also be in a form that allows easy retrieval. This characteristic is somewhat spill and equipment specific, but common types of absorbents are small sheets or pillows, approximately 24 inches by 24 inches. After the sorbent has become saturated, it is placed in open-top containers that are compatible with the spilled substance. It is important to remember that the saturated sorbent still presents many of the hazards of the spilled substance.

If the water is flowing, sorbents must be stabilized either directly by attachment or by containment with a dam or boom. Careful selection of the sorbent and use of the appropriate tools for handling the saturated sorbent (i.e., very simple equipment such as rakes or screens), will minimize the amount of labor required.

Advantages	Disadvantages
• Minimal training - Removes thin layers on water • Reduces vapor emissions from evaporation	• Saturated sorbents occupy more volume than the spilled substances • The process is slow

Suction (Land and Water)

The purpose of this technique is to remove the liquid by suction through hoses or pipes. Specific mechanisms range from hand pumps to sophisticated vacuum trucks. Ideally, the spilled substance collects in a container, (vacuum truck tank, 55-gallon drum, etc.) before passing through the pump. This technique can be applied successfully to a wide range of spill sizes. However is inappropriate for shallow, widely dispersed spills.

In practice, the suction intake is positioned to receive the spilled substance and the pump is activated. The depth of the intake can be controlled to separate bi-phase liquids. Potential hazards created by passing flammable liquids or gases through pumps must be considered. The vapor outlet for the system must be located such that flammable gases do not contact ignition sources.

Floating or suspended debris that may clog the system. This problem can be prevented by using a filter/screen over the end of the suction line. Leaks in the suction tubing will noticeably decrease suction efficiency. This can be prevented by instituting a regular-maintenance and leak testing program. Finally, the movement of air or liquid through the tubing system may generate static electricity and lead to sparks. This potential ignition source can be prevented by grounding the pumping equipment and related tanks.

Advantages	Disadvantages
• Versatile • Can be applied at desired depths to separate liquids • Long lengths of hose can remove substances from limited access sites • Exposure can be minimized • Low labor requirements	• Effectiveness decreases in large spill situations • Viscous substances cannot be moved • A power source must be available • Considerable training is required • There is a potential for mechanical failures • Vulnerable to damage by certain chemicals • Collection device equipment is needed

Excavation of Land

The purpose of this technique is to remove contaminated soil from the spill site. This is the last resort, to be used only when other techniques have failed and the soil has served as a natural sorbent. This choice of clean-up will frequently required notification to local environmental agencies and permits may need to be filed. Reporting will be driven by the type and quantity of material spilled into the soil.

As when using sorbents, it is important to prepare for the hazardous properties of the substance sorbent combination. It is also important to have appropriate containers to receive the contaminated soil. Common difficulties are physical problems associated with excavation such as hard soils. It may also be difficult to determine how much excavation is necessary. Toxic measuring techniques, such as pH paper, or air monitoring instruments can aid in determining the extent of excavation (i.e., with a basic spill the pH of damp soil can be measured during excavation until the remaining soil matches background levels).

Advantages	Disadvantages
• Simple • Minimal training • Readily available equipment	• May require removal of large quantities of materials • Not effective in areas with water tables close to surface • Excavated soil must be replaced • May not eliminate volatilization

Dilution, Dispersion In Air and Mist Knockdown

For years the traditional solution to chemical spills has been dilution with water, especially with fire departments. Although a water flush may decrease chemical reactivity, the material will not be detoxified. Large quantities of water may be necessary before dilution alone can be used to mitigate a spill. Usually the addition of water greatly increases cleanup costs and can increase the danger of public and environmental contamination. Therefore, dilution should always be viewed as a last resort.

Fans or blowers can be used to mix and transport chemical spill vapors with uncontaminated air. Use of this technique will depend on meteorological conditions, the area of the spill and the general nature of the chemicals. Dilution and dispersion are generally only appropriate if the vapors are relatively non-toxic or if people are not nearby. Mist Knockdown is used under extreme circumstances when there is high air toxicity and a need to provide some immediate protection to human life. Mist knockdown can create large quantities of hazardous liquids that can endanger the environment and potentially exposed individuals.

Dispersion In Air and Dilution With Water

Advantages	Disadvantages
• Immediate reduction of high concentrations • Can direct toxic vapors away from populated areas	• Difficult to control in adverse wind or rainy conditions • Large capacity blowers are often needed • Unsafe for untrained personnel • May be prohibited by federal, state, or local regulations • May create large quantities of hazardous waste water • Large containment area is needed for resulting water • Possible water pollution problem is created • Negative impact on public relations

Mist Knockdown In Air

Advantages	Disadvantages
• General availability of water sources • Prevents dispersion of vapors • Can provide some immediate relief	• May create large quantities of hazardous waste water • A large containment area is needed for resulting water • Possible water pollution problem created • Ineffective for high-density, water insoluble vapors • Unsafe conditions created if substance reacts violently with water • Difficult to control in adverse wind conditions.

Neutralization of Chemical on Land

Neutralization is a common technique used for the treatment of acid or alkaline hazardous substances. The process of neutralization is the interaction of an acid with an alkaline (or base) for the purpose of pH adjustment. Neutralization implies adjustment of pH to approach a value of 7, although values between 6 and 9 are usually acceptable.

The bi-products of the neutralization processes are usually water and salt. For instance, in the neutralization of hydrochloric acid by caustic soda (sodium hydroxide), water and sodium chloride (table salt) are formed. If the salt formed is not soluble in water it will precipitate, forming a sludge that must be disposed. Acid/base neutralization is a slow process. Weak basic materials that may be used include sodium carbonate and active lime. The use of a strong base, such as calcium hydroxide or soda ash, requires care in application so the HazMat Technician responder does not receive chemical burns.

Caustic spills are much more difficult to neutralize because there may not be an adequate supply of weak acids on-site. Most weak inorganic acids such as hydrogen cyanide and sulfur dioxide are poisonous but weak organic acids such acetic or citric acids can neutralize basics substances. On-site neutralization must not be attempted unless a chemist and pH measurement equipment are available. The most common field use of neutralization by an emergency response team is when an acid spill has reacted with a base, or vice-versa.

Advantages	Disadvantages
• Reduces initial high concentration • Suitable to spill situations • Minimal auxiliary equipment required for small spills	• Materials may not be readily available • Trained personnel are necessary • A possible secondary environmental Hazard is created if application is overshot and used in excess • Possible exothermic reaction may cause bubbling, frothing, or spattering, or may present cleanup difficulties. This effect can be reduced if the neutralizing agent is combined with fly ash • Specialized equipment may be necessary • Neutralizing chemical may be toxic

Universal Gelling Agents on Land and Water

A multipurpose gelling agent can be used to treat a hazardous substance on land or floating on water. A gelling agent will typically be a blending of at least four specific ingredients. The majority of these products contain polyvinyl alcohol. The agent can be dispersed with shovels, hand pump

dusters, dry chemical fire extinguishers, or sandblasters. Universal gelling agents can also be used to immobilize a spill floating on water.

Advantages	Disadvantages
• Compatible with a variety of substances • Easily removed by mechanical means for disposal • Innocuous thickening, no exothermic reaction • May prevent percolation • May prevent vaporization • Fairly rapid	• Equipment and material may not be readily available for quick response • May be ineffective in adverse wind conditions. • Negative impact on fish, which tend to mistake • material for food

Spill Response Materials

Very few general methods exist to clean-up spills in the shipyard. Once the safety of personnel near the spill has been addressed, the hard work of clean-up and decontamination must begin. Spills may be diluted, absorbed, and/or neutralized. The exact choice of procedures depends on the chemical toxicity, quantity involved, the spill location and what materials are immediately available. In this section, we will present some technical information about the various spill response products and material types.

Bulk Absorbents

A variety of materials have been suggested and used over the years to convert a liquid spill into a more tractable solid material. Those that are commonly available under various trade names are combinations of vermiculite, perlite, or diatomaceous earth. While these all can be used, each has properties that render them less than ideal.

Activated Charcoal

When applicable, activated charcoal is the adsorbent of choice for flammable or non-polar liquid spills. Activated charcoal adsorbs the free liquids and prevents flammable vapors from escaping. Activated charcoal is quite effective in controlling flammable vapors. Diethyl ether, as a liquid normally has a flash point of about 50^{o}F. This flash point increases to over 200^{o}F when adsorbed on activated charcoal. Similarly, toluene changes from about 400^{o}F to over 2,000^{o}F. While charcoal is expensive, this vapor control quickly and effectively reduces both the fire hazard and the health risks related to the spill. Activated charcoal is also very effective on non-polar liquids such as liquid bromine. However, it must never be used with strong oxidizers such as hydrogen peroxide.

Phenolic Granules

Phenolic granules are the newest of the absorbents and have gained acceptance in the 2 to 3 years they have been on the market. They absorb up to 15 times their own weight and are compatible with virtually any chemical. The few exceptions include concentrated nitric acid and unstable cyanides and peroxides. This absorbency and compatibility make phenolic granules especially popular with fire and HazMat crews. There is little space on emergency vehicles to store absorbents. Phenolics are very light and are compacted and baled for shipping. When using phenolics, only one type of absorbent is needed because of the excellent compatibility factor.

The most popular version of phenolics now being marketed is foamed granules. The foaming process provides a cellular structure that quickly captures liquids and provides excellent holding

power. As with most absorbents, phenolics are also available in socks, pads and pillows for containment of leaking hazardous material.

As for disposal, phenolics are suitable for all three methods of landfilling. They are non-biodegradable, incineration, because of their low ash content and fuel blending, because of their high Btu content. The heating value of the absorbent ranges from 10,000 to 13,000 Btu/lb. When solidified with phenolic resin absorbents, sludges, paints, oils, greases, inks, coatings, solvents and adhesives can be used as a 99.9 percent clean-burning substitute for other fuels.

> Safestep (tm)_While it is claimed that Safestep(tm) will clean up practically everything, it works most effectively on oils, hydrocarbons and petroleum related products. It can be used on aqueous spills, but more is required than for oil spills. Safestep(tm) is quite dense and relatively non-dusty. This makes it acceptable for inside use, where other materials produce sufficient dust to damage equipment or spread contamination.

Clay

Clay is the most popular type of absorbent, which stems from initial cost and industry familiarity. Clay is mainly applicable to oil and other petroleum based substances. It comes in rough textured granules that can be distributed liberally over the spill. The granules create a rough surface that can be walked on. The most common applications are in machine shops and maintenance shops. Although clay has a low initial cost/pound, once clean-up and disposal are complete, it is one of the most expensive bulk absorbents. This is mainly driven by poor pick-up efficiency when related to the original weight of the clay.

Polypropylene Absorbent Materials

A variety of materials have been introduced to absorb spills or to prevent the spill from spreading. In general these divide into two classes: those that absorb oil and those that absorb aqueous (water based) solutions. Polypropylene, a common plastic, can be treated in a variety of ways to make it highly absorbent to various oils or aqueous solutions. Absorbent polypropylenes are available in dikes, booms, pads, pillows and wipes.

The liquid sorbent material (for water based spills) is a polypropylene fabric that will rapidly collect most aqueous chemicals including acids and caustics. It works very well in, under and around machinery and equipment. The fabric does not present additional disposal properties that need special attention, so the spill residue can be disposed of as required for the spilled chemical. The fabric absorbs up to 10 times its own weight of many liquids. Some systems enable spilled material to be rung out and the absorbent material is reused.

Neutralization Products

Acid and caustic neutralization is the most common treatment practice for spills. Sodium carbonate, sodium bicarbonate and various alkyl amines are used to neutralize acids. While inexpensive, carbonate based products tend to produce large amounts of carbon dioxide gas, which entrains the spilled liquid and spreads the spill. In addition, the residue is very messy and difficult to clean-up adequately. Due to the problems associated with such materials, other materials were sought for acid spill response. A combination of liquid sorbent pads and liquid neutralizers proves very successful. The liquid neutralizer is an aqueous solution of triethanolamine with a pH indicator. The concentration of this product is such that large quantity spills should *not* be neutralized in place. While this is possible, the volume will increase up to five-fold, depending upon the concentration of the acid.

Neutralizing Agents For Acid Spills	Properties
Calcium Carbonate (limestone)	• Safe to handle • Can be used in excess without secondary environmental hazards • Generally available • Degree of fineness varies over a wide range, affecting its suitability for some spills.
Sodium Bicarbonate	• Safe to handle • Generally available • Can be used in excess without secondary environmental effects • Difficult to find in bulk quantities sufficient to neutralize large spills.
Calcium Oxide	• Quicker and more complete reaction than carbonates • High heat production can cause vigorous boiling and catastrophic spatters.
Sodium Carbonate (soda ash)	• Quicker and more complete reaction than c • May produce hazardous basic chemical when used in excess.
<u>Neutralizing Agents for Bases</u> **Sodium Dihydrogen Phosphate & * Sodium Bicarbonate**	• Safe to handle • Can be used in excess without secondary environmental effects • May be difficult to find in bulk quantities. • * Dilute acetic acid (vinegar)

Caustic spills have routinely been neutralized with solid citric acid. This is very effective and can be used in locations where the messy residue can be easily cleaned up. Liquid caustic neutralizer, which is an aqueous solution of citric acid, triethanolamine and a pH indicator, works effectively and leaves no mess for final clean up.

The pH indicators used in these products show the extent of neutralization. Color changes occur under both white and yellow (photographic or lithographic) light. Both types of liquid neutralizers are best applied using a pesticide-type sprayer. It is suggested that the unit be filled to 3/4 capacity and that it **Be Properly Labeled**. Three pesticide sprayers are needed, one for each neutralizer and one for water. The units should be left filled but unpressurized when not in use.

Small kitchen types of hand sprayers are also very useful. These can be used to decontaminate equipment and various surfaces, as well as "spot" the spill with the color indicator. More examples of
neutralizers are:

1. Spills of Oxidizers neutralized with sodium bisulfite or ferrous sulfate or sodium thiosulfate.
2. Spills of reducers neutralized with sodium hypochlorite.

These situations require specialized knowledge of chemistry and an understanding of local ordinances. It is wise to plan in advance for responding to potential spills that can involve strong oxidizers or reducers.

The chemical oxidation/reduction processes uses a chemical reaction to detoxify hazardous wastes. This is one of the most common chemical reactions. Electrons are transferred from one reactant to the other and in the process chemical bonds may be broken, thereby converting a toxic material into simpler and less toxic chemical. Oxidation is used more frequently then reduction. Both organic and inorganic substances can be treated by chemical oxidation. Examples of substances that can be detoxified by oxidation are cyanides, sulfur compounds, lead, pesticides, phenolics, aldehydes and

aromatic hydrocarbons. Oxidation cannot be used if the toxic substance is dissolved in an organic solvent because the oxidizer will react with the solvent.

Spill Equipment List

A shipyard that uses chemicals, regardless of its size, needs some basic equipment in order to respond to a spill. The actual choice of equipment is based on several considerations. The following table provides a basic list of clean-up equipment that should be considered:

Shipyard HazMat Technician Clean-up Materials List

Quantity	Response Media and Tools
3 x 5 gallons	LIQUID ACID NEUTRALIZER
3 x 5 gallons	LIQUID CAUSTIC NEUTRALIZER
4 x 55 POUNDS	ACTIVATED CHARCOAL
1 pallet	BAGS, SAFESTEP(tm)
2 case	OIL SORBENT PADS
2 case	LIQUID SORBENT DIKES
2 case	LIQUID SORBENT PILLOWS
2 case	AQUEOUS SORBENT PADS
1	PAIL, PLUG N' DIKE
1	SET, LEAK SEALING PLUGS
depends	GALLONS, HAZMAT FOAM, ACID
depends	GALLONS, HAZMAT FOAM, CAUSTIC
3	ALUMINUM SHOVELS
3	PUSH BROOMS
1	VOICE GUN
1	BANNER GUARD ROLL, “CAUTION DO NOT CROSS”
1	55 GALLON DRUM
1	FLASHLIGHTS, BATTLE LANTERN TYPE
1	W-70 10' CRESCENT WRENCH
1	W-214 SAFETY PIPE WRENCH
1	DRAEGER ANALYSIS KIT, COMPLETE
1	OXYGEN METER
1	COMBINATION METER, OXY/EXPLOSION, COMPLETE
1	HANDHELD GAS METER
1	TRAILER, CART, OR VEHICLE

Other equipment that is usually needed include duct tape, hand tools, pH paper, chemical tests, etc. A copy of the shipyard written emergency spill plan should also be included with the supplies, as well as other reference materials.

All of this equipment must be kept available and in working order. Labs and research environments find that small movable units that can be placed into a service closet are very useful. Industrial locations usually need a spill system on a small truck or trailer. It is frequently found that several satellite units are more functional than a single centrally located system. The decision of the types of units to install and how to equip them depends on many shipyard specific factors and must be carefully considered.

Shipyard Spill Response Guide

The following sections provide a detailed guide for HazMat Technician response to a wide variety of chemical spills. The guide is designed to be used by trained personnel only. Use the chemical list, at the end of this section to locate the recommended Guide # for specific chemicals. The guide number provides a reference to the procedure for cleaning up the spill. All HazMat Technicians are cautioned that each spill is unique and the information presented is only a guide that must be supplemented by knowledge, training and experience.

RESPONSE # AND MATERIAL TYPE #	MINIMUM PPE LEVEL
GUIDE # 1: ACIDS (Corrosives)	Level C
GUIDE # 2: WATER REACTIVES	Level C
GUIDE # 3: CAUSTICS	Level C
GUIDE # 4: OXIDIZERS	Level B
GUIDE # 5: REDUCERS	Level B
GUIDE # 6: POISONS OR TOXICS	Level C
GUIDE # 7: REACTIVES	Level B
GUIDE # 8: GASES	Level B
GUIDE # 9: FLAMMABLE MATERIALS	Level B
GUIDE # 10: LOW-HAZARD MATERIALS	Level D

GUIDE # 1: ACIDS (Corrosives)

Liquid Neutralizer Methods: Acids should be absorbed on polypropylene pads, which should be placed in an appropriate container (5 gal plastic pails or lined drums), secured and then transported to the hazardous waste yard for treatment or disposal. The remaining acid residue should be neutralized using a liquid acid neutralizer. The neutralized residue should be absorbed on pads and placed in appropriate containers. This material should be treated as a hazardous waste until determined otherwise.

The neutralization process should be performed at least three times. After each use, the contaminated site should be analyzed using pH paper. Additional treatment should continue until all acid residue is neutralized. Final clean-up should be performed using normal and appropriate maintenance procedures for the contaminated area.

Sodium Bicarbonate Neutralizing Methods: Free liquid should be diked and contained with the solid neutralizer. Sufficient material should be spread over the spill to just cover the surface with a light coating. Thoroughly mix the solid neutralizer with the acid to effect absorption of all free liquid. If necessary, a small quantity of water may be added to cool the slurry or increase the rate of neutralization. If the solid neutralizer does not contain a color indicator, pH paper should be used to check progress of neutralization reaction. The responders should attempt to maintain the final pH in the range of 6 to 10.

After all free liquid is absorbed and the residue is containerized, the area should be rinsed at least twice with water to remove residual contamination and excess solid neutralizer. Final clean-up should be performed using normal and appropriate maintenance procedures for the contaminated area.

Solid Acid Spills: Small spills can be cleaned up mechanically with a dust pan and brush. Larger spills should be cleaned up using a high efficiency particulate filter vacuum. Place the material in an appropriate container (5 gal plastic pails or lined drums), secure and label the container for transport to the hazardous waste yard for ultimate disposal. Any remaining acid residue may be neutralized using a liquid acid neutralizer. The neutralized residue should be absorbed on pads and placed in appropriate containers. This material should be treated as a hazardous waste until determined otherwise.

NOTE: If it is appropriate to wet the acid to reduce dusting, prior to clean up, WATER IS USUALLY NOT AN APPROPRIATE CHOICE. A non-reactive, viscous liquid such as ethylene glycol is better choice. The HazMat Technician must make this determination for each solid spill.

GUIDE # 2: WATER REACTIVES

Use the same response as described for ACIDS. Prior to adding acid neutralizer, <u>slowly</u> and <u>carefully</u> add ICE WATER, until the reaction ceases. This procedure requires extreme caution and should only be used by experienced and trained personnel. When the above procedure is not possible, carefully absorb the spilled material on polypropylene pads and place in a plastic drum. Remove yourself from area and contact supplier for further handling instructions. Decontaminate the residue remaining by spraying cold water on the contaminated surfaces and handling the resulting solution as for an acid.

GUIDE # 3: CAUSTICS

Throw polypropylene pillows around and on the spill in such a manner as to prevent the spread of the spill, indicate its boundaries and reduce fuming by covering the surface. If this has not been performed prior to the arrival of The HazMat Technician it should be performed as soon as possible.

Using Liquid Caustic Neutralizer As much free liquid as possible should be absorbed with polypropylene and transferred to plastic waste containers. If absorption is slow due to the viscosity of the spilled material, careful application of a minimum amount of liquid caustic neutralizer to the spill boundary, should enhance absorption.

Free liquid should be diked and contained with the solid neutralizer. Sufficient material should be spread over the spill to cover the surface with a light coating. The solid should be thoroughly mixed to effect absorption of all free liquid. If necessary, a small quantity of water may be added to cool the slurry or increase the rate of neutralization. If the solid neutralizer does not contain a color indicator, use pH paper to check progress of neutralization reaction. The responders should attempt to maintain the final pH in the range of 4 to 8.

After the majority of the liquid has been absorbed and removed, the responders should begin applying liquid caustic neutralizer to eliminate any caustic residue. Allow several minutes of soaking to provide for neutralization of spilled caustic that may have leached into porous surfaces.

If floor tiles or equipment are involved, the responders must be certain to examine all surfaces and hidden areas for free liquid or residual contamination. Clean room floor tiles must be removed for neutralization with a liquid caustic neutralizer. At least two (2) water rinses of the area must be performed to completely remove any residual liquid.

The remaining caustic residue should be neutralized using a liquid caustic neutralizer. The neutralized residue should be absorbed on pads and placed in appropriate containers. This material should be treated as a hazardous waste until determined otherwise. This neutralization treatment should be performed at least three times, after which the contaminated site should be analyzed using pH paper. Additional treatment should continue until all caustic residue is neutralized. Final clean-up should be performed using normal maintenance cleaning procedures for the contaminated area.

Once all of the caustics liquid spill is absorbed on polypropylene pads and placed in an appropriate container (5 gal plastic pails or lined drums), the container should be secured and labeled for transport to the hazardous waste yard for ultimate disposal.

Solid Citric Acid Neutralizing Methods: Free liquid should be diked and contained with the solid neutralizer. Sufficient material should be spread over the spill to cover the surface with a light coating. Thoroughly mix the solid neutralizer with the caustic to effect absorption of all free liquid. If necessary, a small quantity of water may be added to cool the slurry or increase the rate of neutralization. If the solid neutralizer does not contain a color indicator, use pH paper to check progress of neutralization reaction. The responders should attempt to maintain the final pH in the range of 4 to 8.

After all free liquid is absorbed and the residue has been placed in a container, the area should be rinsed at least twice with water to remove residual contamination and excess solid neutralizer. Final clean-up should be performed using normal and appropriate maintenance procedures for the contaminated area.

Solid Caustics Spills: Small spills can be cleaned up mechanically with a dust pan and brush. Larger spills should be cleaned up using a high efficiency particulate filter vacuum. Place the material in an appropriate container (5 gal plastic pails or lined drums), secure and transport to the waste water treatment shipyard or the hazardous waste yard for treatment or disposal. Any remaining caustic residue may be neutralized using a liquid caustic neutralizer. The neutralized residue should be absorbed on pads and placed in appropriate containers. This material should be treated as a hazardous waste until determined otherwise.

NOTE: If it is appropriate to wet the acid to reduce dusting, prior to clean up, WATER IS USUALLY NOT AN APPROPRIATE CHOICE. A non-reactive, viscous liquid such as ethylene glycol is a better choice. The HazMat Technician must make this determination for each solid spill.

GUIDE # 4: OXIDIZERS

Liquid Oxidizer Spills: Remove or moisten all combustible materials affected by the spilled substance. If oxidizer is not water reactive, dilute to less than 5% (estimated) and absorb with polypropylene wipes or SAFESTEP(tm). Place in an appropriate container (5 gal plastic pails or lined drums) , secure and then transport to the waste water treatment shipyard, or the hazardous waste yard, for treatment or disposal. If neutralization of the oxidizer is necessary, use dilute (5%) sodium thiosulfate in water.

Solid Oxidizer Spills: Small spills can be cleaned up mechanically with a dust pan and brush. Larger spills should be cleaned up using a high efficiency particulate filter vacuum. Place the material in an appropriate container (5 gal plastic pails or lined drums), secure and transport to the waste water treatment shipyard, or the hazardous waste yard, for treatment or disposal. Any remaining oxidizer residue may be neutralized using dilute (5%) sodium thiosulfate in water. The

neutralized residue should be absorbed on pads and placed in appropriate containers. This material should be treated as a hazardous waste until determined otherwise.

GUIDE # 5: REDUCERS

Liquid Reducer Spills: If reducer is not water reactive, dilute with water to less than 5% (estimated) and absorb with polypropylene wipes or SAFESTEP(tm). Place in an appropriate container (5 gal plastic pails or lined drums), secure the load and then transport to the hazardous waste yard for treatment or disposal. If neutralization of the reducer is necessary, use household bleach or a 5% hypochlorite solution. If the spill chemical is water reactive, refer to the specific chemical on the chemical list for guidance.

Solid Reducer Spills: Small spills can be cleaned up mechanically with a dust pan and brush. Larger spills should be cleaned up using a high efficiency particulate filter vacuum. Place the material in an appropriate container (5 gal plastic pails or lined drums), secure and label the container for transport to the hazardous waste yard for proper disposal. Any remaining reducer residue may be neutralized using household bleach or a 5% hypochlorite solution. The neutralized residue should be absorbed on pads and placed in appropriate containers. This material should be treated as a hazardous waste until determined otherwise.

GUIDE # 6: POISONS OR TOXICS

Liquid Poison Spills: Absorb the free liquid using polypropylene pads or SAFESTEP(tm). Place in an appropriate container (5 gal plastic pails or lined drums) , secure and then transport to the waste water treatment shipyard, or the hazardous waste yard, for treatment or disposal.

Remove spill residue by carefully washing area with water and detergent. (If material is water reactive or insoluble in water, use appropriate solvent.) Absorb wash water on pads or SAFESTEP(tm) and place in an appropriate container. Treat this material as a hazardous waste until testing determines otherwise.

Solid Poison Spills: Many solid spills present unusual toxicity or physical hazards. For example, spilled sodium cyanide is extremely toxic, since sufficient dust may be breathed to cause acute health effects. Spills of finely divided metals present an extreme fire hazard and spills of corrosive solids, such as cement or caustic soda present a severe, but delayed chemical burn risk.

If the dust must be wet prior to clean up, WATER IS USUALLY NOT AN APPROPRIATE CHOICE. A non-reactive, viscous liquid such as ethylene glycol is a better choice. The HazMat Technician must make this determination for each solid spill.

Small spills can be cleaned up mechanically with a dust pan and brush. Larger spills should be cleaned up using a high efficiency particulate filter vacuum. Place solid in plastic bags and seal bags. Place bags in an appropriate container (5 gal plastic pails or lined drums), secure and label the container for transport, to the hazardous waste yard, for proper disposal.

GUIDE # 7: REACTIVES

WATER REACTIVE MATERIALS CONSIDER EVACUATION OF BUILDING

If possible, dilute material with appropriate substance to reduce reactivity. If there is a potential that the reactive will come in contact with water, cover the spilled material with mineral oil. Absorb with

polypropylene wipes or SAFESTEP(tm), place in an appropriate container (5 gal plastic pails or lined drums), secure and then transport to the waste water treatment shipyard or the hazardous waste yard for treatment or disposal.

GUIDE # 8: GASES

All "uncontrolled" compressed gas releases must be handled by the HazMat Technician. If the gas is an atmospheric gas (nitrogen, oxygen, carbon dioxide) clear the affected floor, otherwise, consider evacuation of the building.

If possible, control the leak using plug and patch techniques. If this is not possible, move the cylinder out of the building or allow the cylinder to completely vent in-place. Use local fire department or contracted support, as necessary during extremely hazardous incidents.

GUIDE # 9: FLAMMABLE MATERIALS

Adequate Fire Protection Must be Provided. The HazMat Technician must be properly protected and must have immediate access to a (minimum) 20 LB ABC dry chemical fire extinguisher or equivalent.

In general, small solvent spills should evaporate rapidly. However, until vapors disperse, the risk of fire or explosion and the health hazards may be quite high. Solvent spills in areas where flammable vapors can accumulate should be monitored with a combustible gas meter. If the concentration of combustible gas exceeds 20% of the Lower Explosion Limit (LEL) responders should withdraw until the atmosphere can be appropriately modified via ventilation. See chemical list for specific chemicals. If the spill is not controlled quickly and adequate ventilation is not provided and the HazMat Technician must consider evacuating the building.

Polypropylene wipes and activated charcoal should be used to absorb flammable liquids. Flammable solids must be covered with a non-reactive material. Where dust is not a problem, activated charcoal should be used to adsorb the solvent spill and to control the vapors. If dust is a problem, low dust polypropylene, absorbent pads should be used whenever possible. Charcoal should be placed in a plastic pail or lined drum. The residue may be vacuumed with a high efficiency particulate, filter protected, explosion proof, industrial vacuum. Solvent soaked pads should immediately be placed into a safety can for removal from the work area. At least one HazMat Technician should maintain *direct control* of an appropriate fire extinguisher, within the immediate vicinity of the spill, until relieved by another HazMat Technician or the Incident Commander.

Petroleum Oil Products, Paints and Freons Spills of chemicals, such as those listed above and many others, including coating solutions, inks, water treatment polymers, etc., are best handled by adsorption onto SAFESTEP(tm).

Create a dike around the spill with SAFESTEP(tm) and then, if possible, apply a light cover of it over the entire surface. Using brooms or shovels (as appropriate), work the SAFESTEP(tm) into the spill. Spill residues can be placed in a plastic pail or lined drum for removal and proper disposal. A second light application of SAFESTEP(tm) is usually sufficient to completely clean up the spill and all residue. For equipment and vertical surfaces contaminated with these products, oil absorbent wipes may be used to clean the areas. An appropriate solvent may be necessary for some situations.

GUIDE # 10: LOW-HAZARD MATERIALS

Low hazard spills are generally cleaned up by the shipyard workers. Low hazard spills are small and low toxicity. Dispose of low-hazardous chemical materials as hazardous until they are determined to be non-hazardous. This should be determined by applicable Federal, State and local regulations.

Session 17. Hazardous Materials Rescue Considerations

Hazardous Materials Technicians may be called upon to rescue persons from various hazardous situations. These situations may be compounded by the existence of physical injury and/or chemical contamination. Such situations require extreme caution and a careful hazard and risk assessment on the part of the rescuer to ensure health and safety.

Introduction

A fine line exists between a responder being a rescuer and becoming a victim. Statistical examination of data available from OSHA reflects the following:

- One occupational related fatality occurs every 5 minutes.
- 170 occupational related injuries occur every 10 minutes.

The potential for the occurrence of an event requiring a rescue effort in the workplace is significant. Consider also that 60% of all confined space fatalities started out as rescuers. What emerges is a sobering picture of responder risk and potential for disaster. Rescue efforts must be initiated and executed safely and competently within the responder's level of training, resources and capabilities.

Hazard and Risk Assessment

Hazardous materials rescue and rescuer safety requires special emphasis on two critical points:

1. The need to get as much information as possible about the situation and chemical.
2. The need to take action when little or no information is available.

When little is known about the condition of victims and/or the status of the situation, rescuers should always base their response efforts upon a worse case scenario. They should consider conservative actions until more information is acquired or the situation becomes more stable. It must be remembered that <u>no action</u> is always an option.

Specific hazards include but are not limited to the following:

- Chemical exposure
- Fire and explosion
- Oxygen levels
- Confined spaces
- Biologic hazards
- Physical safety hazards
- Electrical hazards
- Heat stress

The following issues need to be addressed as a priority:

1. Safety of personnel
2. Isolation of hazards
3. Notification and requests for assistance, (remember the need for the buddy system as well as the need for a " back-up " team)
4. Command direction, leadership, coordination, supervision and communications
5. Identification of the product(s) involved and associated hazards and risks
6. Action planning and objective determination
7. Protective equipment needs and limitations

8. Counter measures needed to mitigate associated hazards and risks
9. Protective action options
10. Decontamination needs
11. Disposal measures
12. Documentation needs
13. Emergency escape routes
14. Evacuation routes

The rescue decision process can be complex and time consuming. Rescue time constraints coupled with a degree of urgency can result in responder compromised personal safety. It is essential that rescuers secure detailed information prior to initiating action. The process of information collection and analysis must be accomplished quickly and accurately.

Incident Information Collection and Analysis

Prior to taking action, rescuers need to ask specific questions and obtain specific information. Many information sources may be available and each should be explored to the fullest. Although, when the situation is life-threatening and time sensitive, rescuers must review at least three sources for confirmation. The following are some questions that a responder must ask:

- What is known from pre-event planning and training?
- What is known about the industrial processes involved?
- What is known from similar situations and conditions experienced in the past?
- What information is available through various internal communications systems?
- What information is available through employees, security staff, witnesses, supervisors, etc. ?
- What information can be gained through observation of such things as physical conditions, marking systems and signage?
- What information can be gained though external sources and outside technical expertise?

Risk Versus Gain

Once all the hazards have been identified and individual risks assessed, then, and only then, should entry be attempted providing there is something to be gained in the attempt.

Personnel Resources

Even a simple "snatch and drag" rescue effort may prove labor intensive and dangerous in a hazardous environment. Entry for rescue will require at least two people and, at a minimum, two additional people in a stand-by role to extract the initial rescue team in an emergency. The size of individual team members is also an issue. Rescue teams and back-ups should be matched in both size and strength to help ensure that an extraction can be performed. Teamwork is essential. Rescue operations are is not the time for independent actions or individual heroics.

YOU ACT AS A TEAM, YOU GO IN AS A TEAM, YOU COME OUT AS A TEAM!

Strategic and Tactical Entry Consideration Tables

The task of entry shall be approached from both the strategic and tactical prospective.

Strategic concerns include:
Chemical exposure potentials require maximum rescuer protection against inhalation, absorption, ingestion and injection (puncture) threats. Chemical exposure, for any victims, may be the cause of the rescue or just a contributing factor, thereby influencing rescue related operational activities.
Fire and explosion potentials may create a need to include flash protection as part of the rescuers protective ensemble. This will add to the rescuers physiological stress load and further encumbering the rescuers vision, mobility and dexterity at a time when all three are critical to mission success.
Oxygen availability, through deficiency or enrichment, may influence rescue operational objectives as a result of oxygen depravation for victims or greater fire and explosion potentials for everyone concerned.
Ionizing radiation potentials may create a rescue situation that requires specialized training and rescue techniques, as well as specialized victim handling, treatment, decontamination, and transportation requirements. Related rescue operations are usually a matter of training, common sense, cleanliness, preparedness and planning.
Biologic hazards involve two threat categories: those associated with etiologic hazards, (disease causing organisms and/or blood borne pathogens) and those that include snakes, spiders, poison oak and the like.
Physical safety hazards include any and all physical conditions which could cause physical (slip, trip, fall, etc.) injuries to both rescuers and/or victims during the rescue.
Electrical shock hazards pose a threat as a result either of physical contact with an electrical current or the potential to become an ignition source in the event of static discharge.
Heat stress is a critical issue for both rescuers and victims. Heat stress injuries can prove life threatening depending upon severity. It is the number one cause of injuries to personnel wearing PPE and respiratory protection.
Cold exposure may cause hypothermia in victims and rescuers alike. Rescue problems may be compounded by the negative influence that cold exposure may have. Mobility and dexterity as well as it's impact upon PPE integrity.
Noise can impact an operation in two ways. Noise can have a detrimental acute and chronic effect upon the hearing of both the rescuer and victim. Noise can also have a negative effect upon operational integrity as a result of impaired communications.

Tactical issues include:
Safety of personnel is paramount. Rescue operations, however, may place the rescuer directly in harms way. Rescue entries should be made from an up wind position to the fullest extent possible. Slope and distance are also critical. The rescuer does not want to be in a position where the potential for engulfment exists, should conditions deteriorate. Rescuers should make every effort to limit their time of potential exposure, maintain the safest distance practical, and shield themselves as much as possible from existing hazard threats.
Isolation of hazards also includes exposure to victims as a possible cause of harm. Contaminated victims may pose a threat to anyone with whom they come in contact. This issue will be compounded if contaminated victims have experienced injuries. In the event that victims are both contaminated and injured, the rescuer will be required to make some significant priority judgment calls. Depending on the situation, the victim may require treatment prior to extraction or extraction, may be necessary prior to treatment. Rescuers rarely chance the further aggravation of a victims injuries by aggressive extrication actions but in the case of rescues involving hazardous materials,

there may be no other choice. Another part of the problem involves where to take the victim once extraction is complete. It may be necessary to move the victim to an area of safe refuge until preparations are complete pursuant to decontamination, definitive care and transportation.
Notification will have a direct impact upon the efficiency and effectiveness of the rescue effort. Lag times need to be kept to a minimum. Given the amount of information required and the resources needed for a successful rescue effort, prompt notification is vital.
Command and coordination is also vital to mission success. There is little room in a rescue effort for leaderless groups or individuals taking independent and/or uncoordinated actions.
Identification of existing hazards and conditions is also critical. Rescuers must take the time to analyze the entire situation prior to taking any action. Time spent in this effort will go a long way in avoiding needless injury to the rescuers and further injury to the victims. It will also help prevent spreading or compounding contamination problems.
Action planning must follow analysis of the rescue situation. By planning out the rescue procedures in advance of execution, the rescuer can greatly enhance the efficiency and effectiveness of the rescue effort.
Protective equipment needs and limitations will impact the rescue as well. In addition to the PPE problems previously stated, the rescuer must remember that PPE was not designed with extrication in mind. The tools and equipment required to free entrapped or entangled victims may represent a threat to PPE ensemble integrity, as well as proving difficult to operate given the added encumbrance of the PPE and the associated physical restrictions.
Counter measures may be necessary to confine, contain and/or redirect product flow in order to facilitate safe rescue operations. Situation analysis and action planning will greatly enhance any such effort.
Protective actions involve ensuring that all non-essential personnel are directed to areas of safety and not allowed free access to the hazard area. In the event of an emergency. it is necessary to account for the whereabouts of all personnel. It is not desirable to spend valuable time to risk the health and safety of rescuers on search efforts of someone that wasn't there in the first place.
Decontamination actions will vary with individual situations. A victim's life threatening condition and the need for immediate medical care may supersede the need for emergency decontamination, however this decision must be made with great care. If at all possible, emergency decontamination procedures need to be initiated prior to victim packaging and transportation. In some cases, if the victim's condition allows, victim decontamination may be accomplished through normal decontamination protocols. If emergency decontamination is required, do not overlook the access to, and the availability of, employee emergency showers and eye wash stations.
Disposal measures must address the victim's clothing, as well as any, and all, waste generated in the rescue effort. If the victim's clothing was removed in the rescue effort or the emergency decontamination process, such items are subject to the same handling requirements as is any other hazardous waste. Remember, however, that these are items of personal property, and require special consideration.
Documentation is also critical. Accurate records such as activity logs, care and treatment records and personnel exposure records are vital to operational integrity.
Escape routes are a must. Never attempt entry to a hazardous area unless multiple routes of escape have been identified, and access to them is unimpeded. An emergency evacuation signal must be established, and no entry for rescue should be attempted, until the said signal is understood, and the area to reassemble is identified.

Radio Communications

Radio communications, though helpful, requires a degree of scrutiny. Radio equipment must be intrinsically sound, unencumbering as possible, and radio discipline strictly maintained.

Ventilation

Ventilation may be helpful in reducing vapor and gas concentrations. Ventilation methods include natural ventilation, mechanical ventilation and forced ventilation. Care must be exercised because airborne releases can be toxic and changing fuel/air ratios can influence the flammability ranges. It should also be noted that a mechanical ventilation device may also be an ignition source.

Rescue Techniques

Expertise in specific rescue techniques are not included as a part of this course, as such skill development requires specialized training.

Victim Care and Treatment

Whether care and treatment is initiated prior to extraction or after extraction will depend upon the specific situation. However, the treatment protocol is universal.

1. Step One: Complete a Primary Survey

- Establish and maintain an airway
- Ensure the victim is breathing or establish a viable air exchange
- Ensure the victim has blood circulation or initiate cardiopulmonary resuscitation

2. Step two: Complete a Secondary Survey

- Control bleeding
- Immobilize obvious or suspected fractures
- Treat for shock
- Facilitate definitive care

Special Considerations:

- Beware of possible cervical injuries
- Remember the need for decontamination
- Provide definitive care providers with any and all pertinent chemical information

Moving the Victim:

Ambulatory victims should be directed to an area of safe refuge or emergency decontamination facilities. Rescuers must minimize physical contact with the victim, especially if the rescuer is not protected with the proper PPE. Victims can be lead by verbal direction or physically by grasping a broom handle or similar device in an effort to negate the need for physical contact. Semi-ambulatory victims will require greater assistance. When handling these victims ensure proper personal protection that matches the threat posed by the hazardous substances involved.

The major difference between non-ambulatory and semi-ambulatory victims is movement. Non-ambulatory victims may require more physical resources in order to facilitate extraction and movement.

Victim Movement Method and Steps

1. Assisted walking, (the one rescuer method).

- Assist the victim to their feet.
- Grasp one arm, place it over your shoulder and secure it by holding the wrist.
- Place your other arm around the victim's waist.
- Help support the victim's weight.
- Help the victim walk.

2. Assisted walking, (the two rescuer method).

- This method is accomplished in the same manner as the one rescuer method except in that it is accomplished by two rescuers, one on either side of the victim.

3. The seat carry, (requires two rescuers).

- The rescuers kneel on either side of the victim near the victim's hips.
- Both help raise the victim to a sitting position.
- Both steady the victim with their arms around the victim's back.
- Both should grasp each others arm in such a way to form a secure back support for the victim.
- Both should place their other arms under the victim's thighs and clasp wrists.
- Both should slowly stand and raise together, transporting the victim in the seated position.

4. The extremities carry, (requires two rescuers).

- One rescuer stands at the victim's head, and the other at the victim's feet.
- The rescuer at the victim's head; kneels and slips the arms under the victim's arms and around the chest, grasping the victim's wrists.
- The rescuer at the victim's feet faces in the same direction as the rescuer at the victim's head.
- The rescuer at the feet kneels with the feet together between the victim's legs.
- The rescuer at the feet grasps the victim at or just above the knees.
- The rescuers stand and carry the victim to safety.
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5. The victim drag, (requires one rescuer).

Carries are preferred to drags due to the support provided for the victim. However, carries may prove ineffective or impractical given the situation. Therefore, it may become necessary to drag the victim to safety.

- Stand at the head of the victim facing in the same direction.
- Kneel down and grasp the victim under the arms at the arm pits or grasp the victim's clothing at the top of the shoulders.
- Drag the victim to safety.

The Rescue Matrix:

What follows is a step by step description of a hazardous materials rescue procedure:

Step 1: Start from an upwind position and at a safe distance.
Step 2: Conduct an initial size-up and determine if rescue is a viable option.
Step 3: Isolate the area in an effort keep the rescue problem from escalating.

Step 4: Notify appropriate rescue response resources and supervisory authority according to appropriate corporate operating procedures.
Step 5: Establish a command and initiate coordination of the rescue effort.
Step 6: Identify all the hazards and risks that are expected to influence the rescue effort and formulate hazard mitigation measures.
Step 7: Formulate a rescue plan of action and share knowledge of the plan with your fellow rescuers.
Step 8: Select and don personal protective clothing and respiratory protection equal to the chemical threat present. Ensure all rescuers do the same.
Step 9: Upon entry to the hazard area, initiate any necessary counter measures required to facilitate rescue.
Step 10: Facilitate the extraction of victims to an area of safety accounting for all victim medical needs in the process.
Step 11: Facilitate the emergency decontamination of the victim, if the situation warrants, pursuant to definitive medical needs. Facilitate decontamination of the rescuers.
Step 12: Ensure all generated hazardous waste is properly disposed of according to local, state and federal requirements.
Step 13: Ensure all appropriate documentation is completed pursuant to corporate policy and the rescue effort is terminated in the same manner.

Hazardous materials emergencies in the workplace can create rescue situations that exceed normal mental, emotional and physical occupational stress levels. Such conditions can comprise hazards and risks for employees exceeding anything the employee has ever experienced. Conditions may exist that pose an immediate threat to health and safety, while at the same time, the employee is tasked with making a true life and death decision. It is essential that employees be prepared for such events. In the event that such skills are needed, the survival of each responder, may indeed hinge on personal safety awareness, the wearing of personal protective equipment, and the efficient and effective use of proper rescue techniques.

Session 18. Hazardous Incident Decontamination Operations

It is widely recognized that some children have contracted mesothelioma and other asbestos-related diseases by inhaling fibers present on the clothing of their parents. Asbestos and other hazardous materials are clearly dangerous and that health hazard is multiplied significantly by the fact that most materials are so easily spread out of isolated areas. Decontamination is the procedure used to control this spread and is the subject of this session.

Decontamination is the process of removing or neutralizing hazardous materials that have accumulated on response personnel and/or equipment at the incident site. It is crucial to the success of the clean-up efforts because it helps prevent the transport of substances to clean areas and the surrounding community. Since rigorous contaminant control procedures can effectively prevent the contamination of respirators, clothing and PPE, it can be critical to maintaining employee health.

Harmful materials can be transferred into clean areas exposing unprotected personnel. While removing contaminated clothing, personnel may come in contact with contaminants on the clothing or inhale them. To prevent such occurrences, methods to reduce contamination and decontamination procedures must be developed and established, before anyone enters a site. These procedures must continue (modified as necessary) throughout site operations.

The extent to which decontamination must be performed depends on a number of factors, the most important being the type of contaminants involved. The more harmful the contaminant the more extensive and thorough decontamination must be. Less harmful contaminants may require less decontamination. The correct method of doffing personnel protective equipment and the use of site work zones minimizes cross-contamination from protective clothing to wearer, equipment to personnel and one area to another. Personnel responding to hazardous substance incident may become contaminated in a number of ways including:

- Contacting vapors, gases, mists, or particulates in the air
- Being splashed by materials while sampling or opening containers
- Walking through puddles of liquids or on contaminated soil
- Using contaminated instruments or equipment

Prompt, safe and effective decontamination procedures are essential to protect both the victims and hazardous materials response team members. Decontamination is important for the following reasons:

- It prevents workers from becoming contaminated when leaving contaminated areas and removing (doffing) their PPE.
- It protects workers' families from contamination when workers return home
- It protects non-contaminated areas from becoming contaminated
- It protects the surrounding environment and community

Decontamination Methods

Decontamination is performed to protect employees, personnel, equipment and the environment from the harmful effects of the contaminants. There are four basic methods of decontamination:

Discarding The process of removing and disposing of the contaminated PPE and equipment.

Dilution	The use of copious amounts of soap and water, or a specific decontamination solution, to flush off, or dilute the contaminants.
Absorption	The use of an absorbing material to trap and hold contaminants.
Neutralization	Chemically altering the contaminant to an innocuous or less harmful state.

Discarding and dilution are the preferred methods of removing contaminants. These methods are easy to implement, effective and relatively inexpensive.

Types of Decontamination

There are five basic types of decontamination as described below:

1. **Primary Decontamination** refers to the decontamination procedures that is provided to personnel working in the Exclusion Zone or the Contamination Reduction Zone. This generally includes responders working in Level A or Level B protective clothing. Primary decontamination may also be referred to as "Level A" or "Level B" Decontamination, or Full Decontamination.

2. **Secondary Decontamination** is sometimes called Medical Decontamination. It refers to decontamination provided to employees that may have been exposed to hazardous chemicals, but are not displaying any related symptoms of exposure. Secondary Decontamination may also be used following Emergency Decontamination for victims displaying related symptoms. During Secondary Decontamination, there is time to contain runoff water and provide for modesty. This level of decontamination might involve the use of tents, trailers, tarps, containment basins and/or showers. Rinse water will be contained in underground tanks if fixed shower systems are in place. Secondary Decontamination is generally too time consuming for victims with immediate life-threatening injuries/exposures.

3. **Emergency Decontamination** refers to decontamination that is urgent, field and/or site expedient. Most often it is performed on employees, civilians or response personnel who have had a direct exposure to hazardous solids, liquids, mist, smoke and certain gases and who are displaying related symptoms. Emergency Decontamination is a two-stage decontamination process. The first stage consists of clothing removal and a gross two-to-five minute water rinse. The second stage is a soap-and-water scrub and rinse. Exposures to the eyes might involve flushing for 15 minutes or longer. The environment and personal modesty are not of primary importance when there are potentially life-threatening injuries/exposures. Emergency Decontamination may be followed by Secondary Decontamination if deemed necessary by local protocol, the Incident Commander and/or the Poison Control Center. Emergency Decontamination will be covered in more detail later in this Session.

Emergency Decontamination followed by Secondary Decontamination is required for exposure to products which may present an immediate danger to the patient. Products that could require Emergency Decontamination followed by Secondary Decontamination are listed in the following table:

Type	Examples
Acids in liquid or mist state	hydrochloric, hydrofluoric, nitric
Alkalis	sodium hydroxide, ammonia, potassium hydroxide
Reactives	chlorine gas, isocyanates, riot control agents
Pesticides	organophosphates, carbonates, chlorine active compounds
Systemic asphyxiants	cyanide
Alcohols	methanol

Secondary decontamination can only be performed with those products that do not present an immediate danger to the patient. There is time to establish a proper decontamination station that will allow for capture/containment of the product and for privacy of the patient. Obviously, this guideline must be tempered with good judgment. For example, if someone is splashed in the eyes, they should receive Emergency decontamination first, regardless of the product. Examples of chemical substances that require Secondary Decontamination only are as follows:

Type	Examples
Hydrocarbons	gasoline
Alcohols	ethanol, isopropanol
Glycols	ethylene glycol

4. Respiratory Decontamination is provided to employees who have had an exposure to a toxic gas. It may be required on an emergent basis for victims displaying observable related symptoms. Respiratory Decontamination involves removing the victims from the hazardous environment and relocating them to a clean and safe location in the CRZ. Since it may include the administration of oxygen, bulky clothing capable of trapping gas should be removed prior to turning the victim over to medical personnel. Respiratory decontamination alone is appropriate only for exposure to some gases. A few examples of gases that require this type of decontamination are shown in the table below.

Type	Examples
Simple asphyxiants	freon, methane, propane
Systemic asphyxiants	carbon monoxide, some nitrates
Respiratory irritants	sulfur dioxide, formaldehyde

5. Equipment Decontamination is utilized to clean equipment so that it can be returned to service and or exit the CRZ into the Support Zone. Equipment Decontamination will be discussed in more detail in a following section.

Initial Planning

The initial decontamination plan assumes all personnel and equipment leaving the Exclusion Zone are grossly contaminated. This is done in combination with a sequential doffing of protective equipment, starting at the first station with the most heavily contaminated item and progressing to the last station with the least contaminated article.

Methods should be developed to prevent the contamination of people and equipment. Using remote sampling techniques, not opening containers by hand, bagging monitoring instruments, using drum grapplers, watering down dusty areas and not walking through areas of obvious contamination are all examples of preventative measures. Specific decontamination procedures at the site are evaluated and determined based on the following:

- The type of contaminant
- The amount of contamination
- The levels of protection required
- The type of protective clothing worn

The initial decontamination plan is modified eliminating unnecessary stations or otherwise adapting it to site conditions. For instance, the initial plan might require a complete wash and rise of chemical protective garments. If disposable garments are worn, the wash/rinse step may be omitted.

Several site-specific factors determine the level and types of decontamination procedures required. Some of these factors are: The chemical, physical and toxicological properties of the wastes.

- The pathogenicity of infectious wastes.
- The amount, location and containment of contaminants
- The potential for and location of exposure based on assigned worker duties, activities and functions
- The potential for wastes to permeate, degrade, or penetrate materials used for personal protective clothing and equipment, vehicles, tools, building and structures
- The proximity of incompatible wastes
- The reasons for leaving or removing equipment from the site
- The method available for protecting worker during decontamination
- The impact of the decontamination process and compounds on worker safety and health

Establishing the Contamination Reduction Corridor

The CRZ and the Contamination Reduction Corridor should be located upwind and upgrade from the Exclusion Zone. The CRZ must be established in a location that is safe to work in without SCBA or specialized chemical protective clothing. However, once the CRC is in place, decontamination personnel must don the required PPE. The CRC controls access into and out of the Exclusion Zone and confines decontamination activities to a limited area. The boundaries of the CRC should be marked off with specific entry and exit points. Barricade tape, delineators, cones or natural barriers may be utilized. A recommended size for the CRC is approximately 15 feet by 75 feet, but it can be any size which is large enough to operate in comfortably, given the complexity of the specific decontamination process.

Placement and Layout of the Decontamination Area

Location:	Between the contamination reduction zone (CRZ) and the support zone, forming the Contamination Reduction Corridor (CRC).
Stations:	The number of stations required is determined by the level of protection required and the severity of the incident. Minimum of 7, maximum of 19.
Area Layout:	Layout a plastic ground over (usually the size of CRC). Two-thirds in the contamination reduction zone and one-third in the support zone.
Area Set Up:	Set up Cones and Flagging Tape To Identify the Decontaminated Area. 1. Six cones on the plastic cover, two in the middle and one in each corner of the plastic cover in the CRZ. 2. Four cones off the plastic cover, two parallel to the contamination reduction zone and two parallel to the clean area. 3. Red flagging tape from the contamination reduction zone to the clean area (support zone). 4. White flagging tape on the border of the contamination reduction zone and support zone to establish the clean area.
Equipment Lay Out:	Stations and Equipment According to Designated Plan

Resources Needed For Decontamination Procedures:

Resources	Description
Personnel:	At least three people will be needed to perform adequate decontamination, one of whom should fill the position of Decontamination Leader. One person should do the initial washing and scrubbing. The second person should rinse and assist with removing clothing/outer garments. Four or five people may be more effective and should be used, if available, to help remove SCBA and assist as necessary. However, the minimum number of decontamination personnel is the number required to safely and completely decontaminate and remove the garments of each employee or team member.
Water:	Water will almost always be required in the Contamination Reduction Corridor (CRC). The Contamination Reduction Zone should have access to a booster line from an Engine or Truck. It may be useful to have a hydrant near by if large amounts of water will be needed. Water can also be obtained through a regular garden hose or emergency showers found on site.
Decontamination Solutions:	Decontamination of personnel, protective clothing and equipment is usually accomplished by scrubbing with a detergent solution (mild green dish soap) using a soft bristle brush. This is followed by rinsing with generous amounts of water. This will be adequate for most situations. When special solutions are required, regional Poison Control Centers or local specialists should be consulted.
Supplied Air Respirators:	Air supply is usually required for the Entry Team. They may be needed for the Decontamination Team as well. Spare air bottles should be available in the decontamination area so that no one is allowed to run out of air before the decontamination process is complete. Air may also be used to remove particulate material.
Protective Clothing:	The level of protective clothing for the Decontamination Team does not have to be as great as it does for the Entry Team. The Decontamination Team is generally exposed only to diluted material that comes off the Entry Team (secondary exposure). They do not have direct contact with the material the way the Entry Team does. If, for example, the Entry Team is wearing Level A suits, it is fairly common to have the Decontamination Team in Level B suits.
Miscellaneous Tools:	Brushes, brooms, wands, sponges, sprayers, towels, tarps, buckets, bags, liners, horns, chairs or stools and some form of catch basin or pool may be needed. Electricity or generators may be needed to operate equipment and lights. Procedures should contain a thorough list of equipment used at each station within the Contamination Reduction Corridor. A trauma bag, resuscitator, suction equipment and triage tags should be available in case of injury, as well as backboards and saw horses or similar equipment to support the injured person during decontamination.
Equipment List:	1. Plastic sheeting or tarpaulins 2 Plastic bags, assorted sizes 3. Scrub brushes, assorted sizes 4. 10 and 55 gallon plastic pails 5. 32-gallon plastic trash containers 6. Plastic wading pools or large plastic tubs 7. Sponges, assorted sizes 8. Mixing spatulas 9. First-aid kit 10. Field shower 11. Soap, brushes and towel for shower 12. Benches 13. Pumps 14. Hoses 15. Spray equipment (including hoses and a variety of spray nozzles)
Decontamination Solutions:	Decontaminating solutions should be specifically formulated to: (1) react with the contaminating compounds to produce less harmful or harmless reaction products, (2) dissolve the contaminants and thereby remove them from the subject for subsequent disposal, (3) neutralize the effects of the contaminant, or (4) any combination of the above.

Recommended Decontamination Equipment

Equipment For Decontamination of Workers and PPE:
• Drop cloths of plastic or other suitable materials on which heavily contaminated equipment and outer protective clothing may be deposited.
• Collection containers, such as drums or suitably lined trash cans, for storing disposable clothing and heavily contaminated personal protective clothing, or heavily contaminated equipment that must be discarded.
• Lined box with absorbents for wiping or rinsing off gross contaminants and liquid contaminants.
• Stock tanks or children's wading pools to hold wash and rinse solutions. These should be at least large enough for a worker to place a booted foot in and should have no drain or a drain connected to a collection tank or appropriate treatment system.
• Wash solutions selected to wash off and reduce the hazards associated with the contaminants.
• Rinse solutions selected to remove contaminants and contaminated wash solutions.
• Long-handled, soft-bristled, brushes to help wash and rinse off contaminants.
• Paper or cloth towels for drying protective clothing and equipment.
• Lockers and cabinets for storage of decontaminated clothing and equipment.
• Metal or plastic cans or drums for contaminated wash and rinse solutions.
• Plastic sheeting sealed pads with drains, or other appropriate methods for containing and collecting contaminated wash and rinse solutions spilled during decontamination.
• Shower facilities for full body wash or, at least, personal wash sinks (with drains connected to a collection tank or appropriate treatment system).
• Soap or wash solution, wash cloths and towels for personnel.
• Lockers or closets for clean clothing and personal items.

For Decontamination of Heavy Equipment and Vehicles:
• Storage tanks of appropriate treatment systems for temporary storage and/or treatment of contaminated wash and rinse solutions.
• Drains or pumps for collection of contaminated wash and rinse solutions.
• Long-handled brushes for general exterior cleaning.
• Wash solutions selected to remove and reduce the hazards associated with the contamination.
• Rinse solutions selected to remove contaminants and contaminated wash solutions.
• Pressurized sprayers for washing and rinsing, particularly hard to reach areas.
• Curtains, or enclosures to contain splashes from pressurized sprays.
• Containers to hold contaminants and contaminated soil removed from tires and the undersides of vehicles and equipment.
• Wash and rinse buckets for use in the decontamination of operator areas inside vehicles and equipment
• Containers for storage and disposal of contaminated wash and rinse solutions, damaged or heavily contaminated parts and equipment to be discarded.

Persistent Contamination

In some instances, clothing and equipment will become contaminated with substances that cannot be removed by normal decontamination procedures. A solvent may be used to remove such contamination from equipment if it does not destroy or degrade the protective material. If persistent contamination is expected, disposable garments should be used.

Guide to Solubility Common Decontamination Solutions

Solvent	Contaminant
WATER	Small-chain hydrocarbons, inorganic compounds salts, some organic acids and other polar compounds
DILUTE ACIDS	Basic (caustic) compounds, amines, hydrazines
DILUTE BASES detergent & soap	Acidic compounds, phenols, thiols, some nitro and suffonic compounds
ORGANIC SOLVENTS alcohols, ethers, ketones, aromatics, straight chain alkanes (i.e. hexane), common petroleum products (i.e. fuel oil, kerosene)	Non-polar compounds such as greases and PCBs (Warning: Some organic solvents can also solubilize the fabrics that the protective clothing is made of)

Disposal of Contaminated Materials

All materials and equipment used for decontamination must also be decontaminated or disposed of properly. Items such as clothing and tools which are not completely decontaminated on site should be secured in drums with liners or double bagged and labeled prior to being removed from the site. Wash and rinse solutions used for decontamination should be tested for possible contaminants. If unacceptable levels of contaminants are found in the run-off water, the water should be treated or retained for proper disposal. This may require transferring the contaminated water to large poly drums, which should then be secured and labeled.

Decontamination Personnel

Decontamination personnel work under the authority of the safety officer or his/her designee and are described in the following table:

Title/ Responsibilities	Duties
Decontamination Unit Leader: The primary responsibility of the decontamination unit leader is to oversee the entire decontamination process and ensure the safety and well-being of all the members of the decontamination team.	• Report and Communicate with the command post. • Assemble with the members of the decontamination team. Brief them on the locations chosen and procedures to be followed. • Inspect the decontamination area after the layout has been completed. • Oversee the decontamination process. • Brief the incident commander of the status of the unit and request demobilization. • Inspect the area after pick up has been made to assure it has been left in a safe condition.
Welfare Person: The primary responsibility of the welfare person is the safety and well being of the exposed incident team members.	• Assist handler in setting out a salvage cover near the hazardous materials unit which will be used for donning the safety equipment. • Lay out required safety clothing and communication equipment. • Don the safety clothing and communication equipment. Obtain a radio. Check with another team members team before donnning the hood. • Conduct a circle of safety with the handler to assure proper protection has been achieved. • Advance to the access control point leading from the exclusion area

	to meet the outgoing incident team members. Make sure all the air hoses are in place and ready to use at the access control point. • Receive the incident team members as they leave the exclusion area. • Join the handler for decontamination and removal of safety clothing once all contaminated personnel have been decontaminated,.
Handler: The primary responsibility of the handler is the physical washing and scrubbing of the contaminated team member. The handler and welfare persons are the only decontamination personnel who physically come in contact with the contaminated team member while going though decontamination.	• Assist welfare person in setting out a salvage cover near hazardous materials unit which will be used for donning the safety equipment. • Lay out the air supply hoses. • Place spare air cylinders near the remote manifold. • Don protective clothing. • Conduct a circle of safety with the welfare person to assure proper protection has been achieved. • Advance to the first pool and receive the incident team member. • Decontamination procedure: • Disconnect the umbilical hose and turn over custody of the team member to the bagger for removal of safety clothing.
D. Rinser: The primary responsibility of the Rinser is to set up the decontamination area and rinse personnel, making sure not to spread the contamination or become contaminated. The Rinser does come in contact with the contaminated persons.	• Confer with decontamination unit leader (health department). • Set up the decontamination area with the bagger. • Prepare the washing solutions as needed. • Don adequate protective clothing. • Assemble at the first pool to wash the contaminated personnel. • Washing and rinsing procedures: • After all the exposed personnel , including the handler and welfare person, have been decontaminated, the Rinser will take the necessary steps to clean and bag his/her protective clothing.
E. Bagger: The primary responsibility of the bagger is to collect the contaminated clothing in an appropriate manner without becoming contaminated and seal the bag to contain the contaminated material.	• Confer with decontamination unit leader (health department). • Set up the decontamination area with the Rinser. • Secure the area to prevent entry by unauthorized personnel. • Don adequate protective clothing. • Obtain additional personnel if needed. • Assemble at the bag area to receive personnel after decontamination. • After all the exposed personnel including the handler and welfare person have been decontaminated the bagger will take the necessary steps to clean and bag his/her protective clothing.

Factors That Can Affect the Extent of Required Decontamination

Each shipyard incident response operation should have standard decontamination procedures and all response personnel should be thoroughly trained to carry out their responsibilities. However, the decontamination process must have enough flexibility to respond to specific hazards or conditions.

Prevention of Contamination is Important:

- Avoid unnecessary contact with potentially hazardous substances. Personnel should not touch or walk through areas of obvious contamination if it can be avoided.
- Use remote sampling devices with long handles.
- Protect monitoring and sampling instruments by bagging or wrapping.
- Wear disposable outer garments and use disposable equipment, when possible.
- Place all discarded contaminated equipment in a designated area.
- Contain all rinse water until tested, when possible.
- Have the CRZ in place prior to personnel entering the Exclusion Zone.
- Minimize contact time with contaminants.
- Stay upwind and upgrade.

The physical and chemical properties of the hazardous material: The extent of personnel decontamination depends on the effects the contaminants have on the body. Contaminants do not exhibit the same degree of toxicity (or other hazard). When it is known or suspected that personnel have become contaminated with highly toxic or skin-destructive substances, full decontamination procedures should be followed. If less hazardous materials are involved, the procedure can be downgraded. Gases are more likely to permeate clothing and skin tissue. Liquids are harder to see and remove, than powders and other solid materials. Low-viscosity liquids may permeate more readily than high-viscosity liquids. Soluble materials will be easier to decontamination than non-soluble materials. Extremely hazardous chemicals require a more involved decontamination process.

The amount and location of contamination: The amount of contamination on protective clothing is usually determined visually. If it is badly contaminated, a thorough decontamination is generally required. Gross contamination may degrade or permeate protective clothing. This likelihood increases with higher air concentrations and greater amounts of liquid contamination. Gross contamination also increases the probability of personnel contact. The more of the body that has been contaminated, the more involved the decontamination process. There is a greater likelihood of harm, due to inhalation or ingestion, if contaminants are located on or near the face. There is also greater likelihood of absorption or permeation into the body if a product is located in other body cavities, (i.e., folds, nails or hair). It is normally recommended to start the decontamination process at the head and then work down. Eyes, ears, nose, mouth, hair, armpits, etc., need to be thoroughly decontaminated. Open wounds also need to be completely irrigated.

Contact time and temperature: The longer a contaminant is in contact with an object, the greater the probability and extent of contamination. For this reason, minimizing contact time is one of the most important objectives of decontamination. Temperature will also increase vapor production, which may in turn affect the rate of permeation.

Level of protection and work function: Decontamination requirements may vary somewhat according to the particular type of protective clothing. The level of suit (A, B or C), the type of suit material, whether the suit is disposable or not and the number of pieces to the suit, are all important factors that need to be considered in developing procedures for decontamination.

Level of protection: The level of protection and specific pieces of clothing worn determine on a preliminary basis the layout of the decontamination line. Each level of protection incorporates different problems in decontamination and doffing of the equipment. For example: decontamination of the harness straps and backpack assembly of the self-contained breathing apparatus is difficult. A butyl rubber apron worn over the harness makes decontamination easier. Clothing variations and different levels of protection may require adding or deleting stations in the original decontamination procedure.

Work function: The work each person does determines the potential for contact with hazardous materials. In turn this dictates the layout of the decontamination line. For example, observers, photographers, operators of air samplers, or others in the exclusion zone performing tasks that will not bring them in contact with contaminants may not need to have their garments washed and rinsed. Others in the exclusion zone with a potential for direct contact with the hazardous material will require more thorough decontamination. Different decontamination lines O& be set up for different job functions or certain stations in a line could be omitted for personnel performing certain tasks.

Location of contamination: Contamination on the upper areas of protective clothing poses a greater risk to employees. Volatile compounds may generate a hazardous breathing concentration

both for the worker and for the decontamination personnel. There is also an increased probability of contact with the skin when doffing the upper part of clothing.

Reason for leaving site: The reason for leaving the exclusion zone determines the need and extent of decontamination. A worker leaving the exclusion zone to pick up or drop off tools or instruments and immediately returning may not require decontamination. A worker leaving to get a new air cylinder or to change a respirator or canister, however, may require some degree of decontamination. Individuals departing the CRC for a break, lunch, or at the end of the day must be thoroughly decontaminated.

Full Decontamination Procedure

Once decontamination procedures have been established, all personnel requiring decontamination must be given precise instructions. Compliance must be frequently checked. Personnel wearing SCBAs must leave their work area with sufficient air to walk to CRC and go through decontamination. The full 19 station decontamination procedure is outlined is for workers wearing level A protection under a worst case scenario. The 19 station procedure is outlined below.

Station and Process	Equipment
Station 1: Segregated equipment drop	Various size containers. plastic liners. plastic drop cloths
Station 2: Boot cover and glove wash. Scrub outer boot covers and gloves with decontamination solution or detergent/water.	20-30 gallon container. decontamination solution, detergent,/water, long handle, soft scrub brushes.
Station 3: Boot cover and glove rinse. Rinse off decontamination solution from station 2 using generous amounts of water. Repeat as many times as necessary.	30-50 gallons containers, high pressure spray water wash, 2-3 long handle, soft scrub brushes.
Station 4: Tape removal. Remove tape around boots and gloves and deposit in container with plastic liner.	Container (20-30 gallons), plastic liners.
Station 5: Boot cover removal. Remove boot covers and deposit in container with plastic liner.	Container (30-50 gallons), plastic liners, bench or stool.
Station 6: Outer glover removal Remove outer gloves and deposit in container with plastic liner.	Container (20-30 gallons), plastic liners.
Section 7: Suit/safety boot wash. Thoroughly wash fully encapsulating suit and boots. Scrub suit and boots with long handle, soft bristle scrub brush and generous amount of decontamination solution or detergent/water. Repeat as many times as necessary.	Container (30-50 gallons), decontamination solution or detergent/water, 2-3 long handle, soft scrub brushes.
Station 8: Suit/safety boot rinse. Rinse off decontamination solution or detergent/water using copious amount of water. Repeat as many times as necessary.	Container - 30-50 gallons, high pressure spray unit, water. 2-3 long handle, soft scrub brushes.
Station 9: Tank change. If worker leaves exclusion zone to change air tank, this is the last step in the decontamination procedure. Workers air tank is exchanged, new outer gloves and boot covers donned and joints taped. Worker then returns to duty.	Air tanks, tape, boot covers, gloves.
Station 10: Safety boot removal. Remove safety boots and deposit in container with plastic liner.	Container - 30-50 gallon plastic liners, bench or stool, boot jack.
Station 11: Removal of the fully encapsulating suit and hard hat. With assistance of helper, remove fully encapsulating suit	Rack, drop cloths, bench or stool.

(and hard hat). Hang suits on rack or layout on drop cloths.	
Station 12: SCBA backpack removal. While still wearing facepiece, remove backpack and place on table. Disconnect hose from regulator valve and proceed to next station.	Table
Station 13: Inner glove wash. Wash with decontamination solution or detergent/water that will not harm skin. Repeat as many times as necessary.	Basic or bucket, decontamination solution or detergent/water, small table.
Station 14: Inner glove rinse. Rinse with water. Repeat as many times as necessary.	Water basin, basin or bucket, small table.
Station 15: Facepiece removal. Remove facepiece. Deposit in container with plastic liner. Avoid touching face with fingers.	Container (30-50 gallons), plastic liners.
Station 16: Inner glove removal. Remove inner gloves and deposit in container with plastic liner.	Container (20-30 gallons), plastic liners.
Station 17: Inner clothing removal. Remove clothing soaked with perspiration. Place in container with plastic liner. Inner clothing should be removed as soon as possible since there is a possibility that small amounts of contaminants may have been transferred in removing fully encapsulating suit.	Container (30-50 gallons), plastic liners
Station 18: Field wash. Shower if highly toxic, skin-corrosive or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.	Water, soap, small table, wash basin, buckets, field showers, towels.
Station 19: Redress. Put on clean clothes. A dressing trailer is needed in inclement weather.	tables, chairs, lockers, clothes

Decontamination of Equipment

Instrumentation	Avoid the contamination of monitoring instruments or other sensitive equipment. Once contaminated, instruments are difficult to clean without damaging them. All instruments should be placed in a clear plastic bag or other protection during use on a hazardous waste site, with small holes for sample intake. For advice on cleaning, contact an EPA Regional Laboratory.
Respirators	Certain parts of contaminated respirators, such as the harness assembly and leather or cloth components, are difficult to decontaminate. If grossly contaminated, they may have to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush. Regulators must be maintained according to manufacturers recommendations. Persons responsible for decontaminating respirators should be thoroughly trained in respirator maintenance.
Heavy equipment	Bulldozers, trucks, back-hoes and other heavy equipment are difficult to decontaminate. Generally they are washed with water under high pressure, and/or accessible parts are scrubbed with detergent/water solution under pressure, if possible. In some cases shovels, scoops and lifts are sand blasted or steam cleaned. Particular care must be given to those components in direct contact with contaminants such as tires and scoops.
Tools	Metal or rubber tools can usually be decontaminated by a simple scrubbing process with detergent solution as described above. Decontamination of wooden tools or other materials that can absorb possible chemical contaminants should never be attempted. These tools should be discarded and disposed with other wastes carried off the site.

Determining the Effectiveness of Decontamination

There is no method to immediately determine how effective decontamination is in removing contaminants. Observable effects only indicate surface contamination and not permeation (absorption) into clothing. Also, many contaminants are not easily observed. There are a number of ways to check the effectiveness of decontamination on protective clothing. However, these methods are not always accurate or practical.

- Visual examination of protective clothing for signs of discoloration, degradation or any corrosive effects.
- Analysis of test swatches or wipe samplings.
- Testing of a representative garment by a qualified laboratory.

Emergency Decontamination

Part of overall planning for incident response is managing medical emergencies. The plan should provide for:

- Full training first aid and CPR for response team members
- Arrangements with the nearest medical facility for transportation and treatment of injured and for treatment of personnel suffering from exposure to chemicals.
- Consultation services with a toxicologist.
- Emergency eyewashes, showers, and/or wash stations.
- First aid kits, blanket, stretcher and resuscitator.

In addition, the plan should establish methods for decontaminating personnel with medical problems and injuries. There is the possibility that the decontamination may aggravate or cause more serious health effects. If prompt life-saving first aid and medical treatment is required, decontamination procedures should be omitted. Whenever possible, response personnel should accompany contaminated victims to the medical facility to advise on matters involving decontamination.

If immediate emergency treatment is required to save the life of a contaminated person, decontamination may be started without a formal and complete Contamination Reduction Corridor. This would mean using emergency shower or eyewash equipment provided in the shipyard incident area.

Emergency Decontamination refers to decontamination that is urgent and field expedient. Most often it is performed on employees or response personnel who have had a direct exposure to hazardous solids, liquids, mist, smoke and certain gases and who are displaying related symptoms. It is a two-stage decontamination process. The first stage consists of clothing removal and a gross 2-to-5 minute water rinse. The second stage is a soap-and-water scrub and rinse. Exposures to the eyes might involve flushing for 15 minutes or longer. The environment and personal modesty are not of primary importance when there are potentially life-threatening injuries/exposures. Emergency Decontamination may be followed by Secondary Decontamination if deemed necessary by local protocol, the Hazardous Materials Response Team and/or the Poison Control Center.

Considerations for Emergency Decontamination:
The first and most important consideration is for the safety of the employee and emergency response personnel. The proper use of PPE and established decontamination procedures will greatly reduce the hazards associated with emergency decontamination. Structural fire-fighting clothing is not designed or recommended for working in hazardous chemical environments and should be avoided. If personnel in structural fire-fighting clothing encounter a hazardous chemical environment, they should take precautions to minimize the chance of contamination.

Secondary contamination to rescue personnel, medical personnel (at the scene and at the hospital), other citizens and transport vehicles and equipment, must be adequately assessed and protected against. The regional Poison Control Center can provide rapid information, 24 hours a day, regarding toxicology, delayed effects, secondary contamination and decontamination requirements for specific chemicals. It should be policy to contact the Poison Control Center as soon as possible. Some substances that pose a high risk for secondary contamination are concentrated acids and bases, cyanide salts and gases, pesticides and phenolic compounds. Employees should review the MSDS, which must be provided by their employer.

General Guidelines for Emergency Decontamination:
A PA system can be used to provide patients with simple instructions. Those who are ambulatory should be directed to remove themselves from the contaminated area. If there are multiple patients they may be directed to different areas based on symptoms. This provides a quick form of triage. If appropriate, patients should be directed to decontaminate themselves by removing clothing and utilizing emergency showers or eyewashes on site. It may be desirable to lay out a salvage cover or plastic sheet to identify where patients should go. A quick pool for containing run-off water can be formed by placing a plastic sheet over a charged hose line that has been formed into a circle.

Shoes, socks, jewelry, watches and any other items that may trap chemicals against the skin must be removed during the decontamination process. The washing and rinsing should start at the head to reduce contamination, on or near the nose, mouth, ears and eyes. Contact lenses should be removed as soon as possible and the eyes should be irrigated. Open wounds should be washed starting from the area nearest the wound and working outward. Saran Wrap may help isolate open wounds once they have been cleaned. A low water pressure system should be used to avoid aggravating soft tissue injuries and to avoid over-spray and splashing.

All clothing and personal effects should be double-bagged and marked with the patients name. These items can be decontaminated or disposed of at a later date. Pre-made decontamination packs with ponchos will facilitate this process. After decontamination, the patient should be wrapped in a disposable blanket, placed in a plastic zip-front body bag, then placed on a clean backboard for transport.
Patients must be transported to appropriate receiving centers. The hospital (or alternate facility) must have a decontamination area, a proper ventilation system, restricted access and formal procedures for dealing with hazardous materials exposures. They must have trained in-house personnel and provide their personnel with proper PPE. Hospitals which do not meet this criteria cannot be considered appropriate receiving centers. It is essential that response personnel be familiar with the medical facilities in their area ahead of time and that they choose the right facility before transporting the patient.

Receiving hospitals must be notified, as soon as possible prior to receiving patients who have been contaminated. They must be provided with thorough information about the chemical(s) involved, the hazards associated with the chemical(s) and the extent of injuries so that they can adequately prepare both personnel and equipment.

Saw horses, buckets or other supporting structures will be required *in* the Contamination Reduction Zone to support backboards or "Stokes" litters during the decontamination process. Patients must be completely disrobed and turned during decontamination to ensure adequate decontamination. Strict attention must be paid to protecting the airway, particularly for patients whose airway has been compromised by exposure to the hazardous material. Decontamination must be performed carefully to ensure the victim does not aspirate the water used. An inclined position and oxygen mask is recommended for such patients. Suction equipment should be on hand nearby.

Decontamination Example Situations:

Example Situation	Actions Taken	Error Made	Results
Example #1 A large chemical manufacturer experienced a chemical reaction in one of its large blending tanks. The primary chemical involved was hexanediacrvlate.	The captain and two fire fighters donned full protective clothing and self-contained breathing apparatus before entering the structure to size up conditions.	Upon exiting the structure the captain walked over to the command post, removed his facepiece and proceeded to report on conditions. His two fire fighters, however, kept their self-contained breathing apparatus facepieces in place until *after* they had taken a booster hose line and decontaminated themselves by thoroughly flushing each other off.	By not decontaminating himself before removing his self-contained breathing apparatus facepiece, the captain breathed lethal chemical vapors that had been evolving from his turnouts. Due to this error, the captain has been medically retired and is expected to die as a result of the chemical vapors permanently altering his central nervous system.
Example #2 An explosion and fire in a chemical mixing plant destroyed portions of a chemical laboratory. The primary chemicals that were involved were hydrochloric acid and butyne.	Fire fighting equipment was arriving and setting up when a California Highway Patrol officer told a fire fighter, "I don't know what's in that smoke, but dead bugs are falling out of the sky onto the hood of my car!" By the time the word was spread to don SCBA, seven fire fighters were suffering from the effects of toxic smoke.	Ambulance crews transported the seven fire fighters suffering from inhalation of toxic fumes and irritation of exposed skin to local area hospitals. These initial seven fire fighters were transported without decontamination or removal of clothing.	By not decontaminating or removing the contaminated turnout clothing, the paramedics and nurses handling the first injured fire fighters soon became ill themselves. This was attributed to the handling of the turnout coats and other clothing that had been contaminated with the toxic chemical fumes.

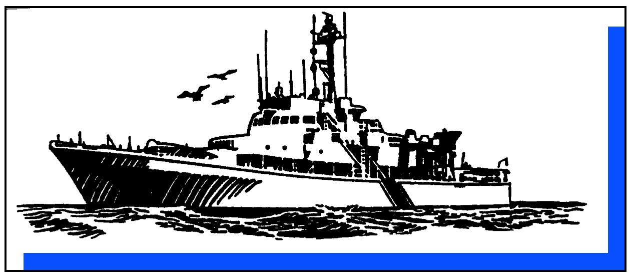
Example Key Points: In hazardous materials situations *always*:

1. Use a decontamination procedure appropriate for the type of product and/or situation.
2. Remove the breathing apparatus facepiece *only after* the decontamination process has been completed.
3. Remove contaminated clothing (after decontamination, residues still remain in the clothing) prior to allowing ambulance/rescue personnel to work on the patient.
4. Remove breathing apparatus facepiece after the decontamination process has been completed. (The facepiece can remain in place until the contaminated clothing has been removed.)

Decontamination Key Points:

- Decontamination of personnel takes priority over establishment of the decontamination area.
- Providing protection to personnel conducting decontamination takes priority over administering immediate decontamination.
- All contaminated clothing and equipment is to be placed into double plastic bags and kept isolated for later disposal.
- Leave all equipment too large to be bagged inside the hot zone.
- Remove the self-contained breathing apparatus facepiece after the decontamination process is completed.
- Contain all water used for decontamination of patients/personnel.
- Consider run-off water contaminated (possibly toxic) and utilize an appropriate procedure to contain run-off water.
- Vapors from run-off water can be toxic. Personnel protective equipment and safety procedures utilized around run-off water should be the same as those utilized within the inner perimeter.
- Personnel conducting decontamination are to decontaminate themselves, utilizing the level of decontamination equal to the level of exposure.
- Decontamination takes priority over modesty or short-term exposure to weather elements.
- Make efforts to reduce exposure to the elements. (Salvage covers hung up as windshields).
- Decontamination procedures for apparatus and equipment depend upon identification of the specific material involved. (Consult with the hazardous material manufacturer for specific recommendations.)
- Major apparatus and equipment decontamination requires coordinating with outside agencies.
- Protecting the environment takes priority over decontaminating apparatus and equipment.
- Safety Never touch personnel being decontaminated. Only the washer will have any contact with personnel being decontaminated.
- Do not leave decontamination area until you have been decontaminated by someone else.

Incident Commander Training



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SP-1 Panel

Incident Commander Training Sessions

Session 1. Introduction to the Incident Commander and Training Objectives

The Incident Commander is the individual who is responsible for and in control of the response effort. An Incident Commander's position should be occupied by the senior, most appropriately trained, individual present at the response site. The position may be occupied by many individuals during a particular response as the need for greater authority, responsibility, or training increases.

Emergency responders expected to perform as Incident Commanders should be trained to fulfill the obligations of the position, including the ability to:

- Analyze a hazardous substance incident to determine the magnitude of the response required.
- Plan and implement an appropriate response plan within the capabilities of available personnel and equipment.
- Implement a response that will favorably change the outcome of the incident in a manner consistent with the local emergency response plan and the shipyards standard operating procedures.
- Evaluate the progress of the emergency response to ensure that the response objectives are being met safely, effectively, and efficiently.
- Adjust the response plan to specific conditions and notify higher levels of response when required by the changes to the response plan.

Incident Commanders, who will assume control of the incident scene beyond the First Responder Awareness Level, shall receive at least 24 hours of training equal to the HazMat Technician Level and have competency in the following areas:

- Know and be able to implement the employer's incident command system.
- Know how to implement the employer's emergency response plan.
- Know and understand the hazards and risks associated with employees working in chemical protective clothing.
- Know how to implement the local emergency response plan.
- Be aware of the state emergency response plan and of the Federal Regional Response Team.
- Know and understand the importance of decontamination procedures.

Designated Responsibilities of Incident Command

Shipyard Incident Commanders have primary responsibility in all hazardous emergency situations. While Incident Commanders may delegate the accomplishment of necessary actions, they must always retain overall responsibility. OSHA regulations stipulate that Incident Commanders are responsible for the following:

- Identification, to the extent possible, of hazardous conditions present at the incident site.
- Ensuring that appropriate technical site analysis occurs.
- Ensuring that appropriate protective equipment is used to minimize worker exposure.
- Ensuring that appropriate site control and decontamination practices are established.
- Ensuring coordination of all emergency responders and their incident actions.

- Ensuring that a "buddy-system" is utilized for entry into hazardous areas and an appropriate back-up/rescue team is established.
- Ensuring that on-scene medical surveillance of responders is implemented, and that first aid and medical transportation is available at the incident.
- Ensuring that appropriate "Incident Objectives" are developed and communicated to responders.
- Remaining cognizant of various responder's training levels under their command and ensuring that only properly trained individuals work in hazardous areas.
- Establishing a "Safety Official" (Safety Officer) with the responsibility to identify hazards and provide direction regarding operational safety.

Note: Incident Commander may be dual tasked to accomplish command and safety functions.

Other duties and responsibilities are established in State and Federal Response Plans, Shipyard Business Plans, and other response planning documents. These duties commonly include:

1. Responsibility for management of all potentially effected employees or outside populations.
2. Ordering of appropriate response resources (internal and external response agencies).
3. Establishing an "Incident Command System" for incident management.
4. Facilitating appropriate operational control, planning, logistical, and scene management to match the size and sophistication of the incident.
5. Ensuring appropriate liaison with affected agencies and responders.
6. Ensuring that safety management, and informational/public relations concerns are adequately addressed.
7. Providing appropriate information, through notifications, to concerned governmental agencies, executive management, and others.

Training Objectives

The objectives of this training and the expected competencies of the Incident Commander are as follows:

- Recognize what hazards are involved with an incident, the risks and negative outcomes that the hazardous substance incident presents, and identify the role of the Incident Commander.
- Recognize hazardous substance incidents via basic clues, warning signs, placards, MSDS, etc. Understand the need for a positive safety attitude and describe a safe approach to a hazardous substance incident.
- Describe basic functions of the Awareness Level Responders, Operational Level Responders, and HazMat Technicians and their associated initial actions.
- Explain purpose, needs, and elements of the shipyard Incident Command System and demonstrate the capability to implement the system during a hazardous substance Incident.
- Explain and perform identification and hazard assessment techniques to aid in “action planning” for a hazardous substance incident management.
- Explain need, types, selection criteria, hazards, risks and limits of PPE commonly used at hazardous substance incidents, and cite the Incident Commander's role regarding protective equipment.
- Identify Incident Commander's role in selecting safe containment and control methods.

- Understand the steps to bring the incident to final closure after stabilization. Provide for proper decontamination and cleanup, and cite the Incident Commander's role in the decontamination and closure process.
- Identify the need for documentation at a hazardous substance incident and demonstrate an ability to properly complete reports as required by law and internal shipyard procedures.
- Recognize typical agencies at a hazardous substance incident (including roles and capabilities). Understand/establish methods to communicate and coordinate with those agencies.
- Be extremely familiar with the shipyard and local pre-event plan, emphasizing how to implement the management system in that plan.
- Understand the health effects that hazardous substances present to employees life safety, and explain the Incident Commander's role regarding the safety and potential exposure of response personnel.
- Describe a "Process" for the safe and competent management of hazardous substance incidents and understand the "Risk vs. Gain" concept.
- Identify the legal role and rights of the media at hazardous substance incidents. Understand the media's capabilities to assist the Incident Commander with evacuation and shelter-in-place.
- Explain the need for investigating a hazardous substance incident and the Incident Commander's role in performing investigations and documentation.
- Describe good management by identifying practical issues in managing a hazardous substance incident.
- Explain the value, types and limits of exercises and critiques for preparing for hazardous emergencies in the shipyard.
- Be aware of current hazardous substance laws pertinent to the shipyard and the Incident Commanders role and be aware of the legal liabilities.

Questions that the Incident Commander should be able to answer

- What incident management system does your hazardous substance plan mandate and what is the Incident Commanders role?
- Is the Standard Operating Procedures (SOP) for Incident Command specified in writing and available?
- Are the Incident Command SOPs consistent with other SOPs for controlling hazardous substance incidents? Can you initiate and control that management system? If Yes How?
- What is the role of the Incident Commander in your shipyard HazMat Incident Response Plan?
- Is the role and responsibility of the Incident Commander consistent with normal duties?
- Are the duties the same as those specified in the employee's job description?
- Who is the State and Local Agency Coordinator for on and off highway hazardous substance incidents?
- Who are the Inland, Coastal Zones, and military installation responders are?
- Do you know the federal recognized response team available to you during a major disaster?

Session 2. The Incident Command System

The Incident Command System should be a customized tool to help Incident Commanders manage major emergencies or disasters. The Incident Command System is a predetermined and standardized emergency/disaster organization and management system. It should be suited for multi-agency/jurisdictional response to several types of major emergencies/disasters, including hazardous material releases, earthquakes, dam failures and floods. The Incident Command System should be designed to make the most efficient use of multi-agency/jurisdictional resources to more effectively combat the effects of a major emergency/disaster. The Incident Command System is a proven tool that can help organize and manage the many agencies and resources that inevitably become involved in a major emergency/disaster.

Coordination: In small, localized emergencies, each department and agency has their own organization and system that works quite well for them in those particular situations. However, in a major emergency, or disaster, there are several agencies and departments working the same situation (i.e., hazardous materials incident), each with their own organization and system. Typically all these organizations and systems do not mesh well together, and poor management and coordination is the result. What is needed for these situations is one common, predetermined organization and management system that is acceptable to all the agencies involved. In many jurisdictions, the Incident Command System has been used as that common organization and management system.

The Incident Command System is based on simplicity, flexibility and sound management practices that can be applied to an emergency/disaster. The Incident Command System operates under the premise that authority will not be compromised, but united. Assisting agencies function, within their capacity, in a compatible Incident Command System position, under the general direction and coordination of a jurisdictional agency or other response organization having Incident Commander authority.

The combining of forces and resources requires cooperation, flexibility and some compromise on the part of all concerned. The system works if there is a mutual understanding and agreement by the participating agencies, of the basic incident operating procedures, common terminology, and structural organization. The following sections provide a basic overview.

Incident Operating Procedures

The Incident Command System begins with the first response unit on scene and continues until management of incident operations is no longer needed. The shipyard response team will start the sequence of the Incident Command System. The shipyard Incident Commander will set-up initial command. If the incident escalates, incident command will be transferred to another organization with greater capabilities.

Emergency responders want to know four basics that the Incident Command System addresses:

- Who's in charge?
- What is my role, responsibility and specific task?
- Where do I fit in to the overall organization?
- Whom do I report to?

Authority:
Every emergency requires a jurisdictional agency that assumes Incident Commander authority and sets up a single or unified command structure.

Positions:
"Position Descriptions" for each Incident Command System position provide easy expansion of the system and act to identify the positions basic role, responsibility and specific tasks to be accomplished.

Organization:
An Incident Command System organization chart, attached to Position Descriptions, shows where a specific position fits into the overall organization and to whom that person reports.

Command:
In an emergency response, the activation of the Incident Command Post is mandatory as a central location for multi-agency/jurisdictional contact, communications and coordination. It will ensure that key agency representatives report to major Incident Command System sections including the Incident Commander, Planing and Intelligence, and Logistics.

Principles on which the Incident Command System is based include:

- Common Terminology
- Modular Organization
- Integrated Communications
- Unified Command Structure
- Consolidated Incident Action Plans
- Manageable Span-of-Control

Organization of the Incident Command System is based on a structure which is identified by common terminology. There is a position title for each position within the Incident Command System. The position title not only identifies the position, but also identifies the level of the position.

The basic structure for position identification is as follows:

- Incident Commander - Commander
- Command Staff - Officers
- Sections - Chiefs
- Branches - Directors
- Groups - Supervisors
- Teams & Units - Leaders
- Areas - Managers

There are also identifiers for each level within the command structure. Criteria for organizational identification is as follows:

- Section - Management Element
- Group - Functional Areas
- Division - Geographical Areas
- Branch - Span of Control Limitations

Since hazardous materials incidents usually involve the fire department, law enforcement agencies and public health agencies, a unified command structure will generally be established. As incidents escalate, an Emergency Operations Center may be needed to coordinate all of the agencies and functions involved. Very large incidents may require a State Operations Center to coordinate statewide mutual aid and outside resources.

Common Terminology

As with any organization with different disciplines working together, common terminology is essential for:

- Position Titles
- Facilities
- Resources
- Inter-Agency Communications

Position Titles: Incident Command System Position titles should be predetermined, standardized and consistent with the agreed upon Incident Command System Organization Chart. When assigned an Incident Command System Position title, agency personnel hold that Position title (i.e., Law Branch Director), rather than the agency title (i.e., Sergeant), during a response.

Facilities: Common identifiers for facilities in and around the incident area are:

Emergency Operations Center: Facility activated only for disaster response as a central location for multi-agency/jurisdiction management, communications and coordination.

Incident Command Post: Multi-agency contact point during a field emergency for management, communications and coordination.

Strategic Area: Location to temporarily hold personnel and equipment until directed to a given assignment and/or mission.

Camp: Location equipped and staffed to provide food, water and sanitation services to incident personnel.

Resources: Many services have categorized their resources. For example, the Fire Services are divided into Single Resources and Individual agency units. Additional examples are outlined below.

Strike Team: A specified combination of same type units with a common communication system and leader.

Task Force: A group of resources with a common communication system and a leader that is temporarily assembled for a specific mission.

Agency Resources: Identified as 1 of 3 status conditions: Assigned, Available and Out of Service.

Resource Lists: List all potential public and/or private resources that may be called upon to assist in an emergency.

Inter-Agency Communications: Responders should avoid codes, agency vernacular or other potential sources of confusion and use "Clear Text" (Plain English) for multi-agency/discipline communications.

Incident Command System Structural Organization

The Incident Command System is an evolving structure based on management needs of the emergency/disaster and the Incident Commanders span of control.

Structure: The Incident Command System is made up of positions or modules that are activated by the Incident Commander. Activated positions (leaders or teams), are filled by assisting response agency personnel, within their capabilities and training. A HazMat response may have from 2 to 50+ positions.

Organization: A predetermined organization chart identifies positions by title. This Incident Command System organization chart shows clear lines of authority. It maintains a manageable span of control by using up to five major sections: Command, Operations, Planning/Intelligence, Logistics and Finance/Administration.

The actual organization structure builds from the top down, with responsibility and performance placed initially with the Incident Commander. As management needs of the emergency are identified, the Incident Commander may activate any other major sections, branches or individual positions as needed. Further, each major section or branch may activate positions within their section or branch, if needed. If one individual can simultaneously manage all positions within his/her responsibility, no further position activation is needed. If subordinate positions have not been assigned, the primary position retains responsibility and performance for the subordinate position. Remember, the organizational structure is designed to help, not hinder. ***Activate positions only when necessary to accomplish the job. Do not fill positions just to serve the system!***

The Incident Command Post

One of the most effective methods for enhancing communications and coordination at the scene of a multi-agency incident is the use of what was previously known as a "Joint/Unified" Command Post. This Command Post is now known as the "Incident Command Post". An Incident Command Post provides for better management, coordination, communication and control of a multi-agency response.

Criteria for establishing an Incident Command Post:

- When more than one agency is needed to respond to the incident.
- When coordination or joint decision making is necessary for response actions.
- When the event is complex or long lasting (i.e., over one day).

Incident Command Post Staffing:

- The first arriving unit should set up temporary Incident Command Post.
- The designated Incident Commander formally establishes the Incident Command Post.
- Each response agency provides a representative to the Incident Command Post with the authority to speak for the agency and commit resources.

Incident Command Post Location:

- Locate the Incident Command Post well away from the event.
- It should be upwind, uphill & upstream.
- It should be at the edge of Support Zone.
- Vehicles headed away from the event may be used as the Incident Command Post.
- Flags, cones, signs, green lights on vehicle, etc., should be used to clearly designate the Incident Command Post location.
- Plan to relocate due to wind shift, new information, etc.

Bottom Line - A coordinated response requires an Incident Command Post

Incident Operating Procedures

In an emergency response to an actual or potential release of hazardous materials, the activation of the Incident Command System is mandatory. The Incident Commander should establish an Incident Command Post (a central location for multi-agency/jurisdictional contact, communications and coordination) for key agency representatives to report. The incident operating procedures will generally flow as follows:

- Upon arrival, the assisting agencies check-in, are assigned an Incident Command System position (with description), and given an objective.

- Other units may report to the Staging Area/Manager at designated "check in" locations to hold their position until assigned.

- The Position Leader will then organize and brief "Teams/Units" as needed, execute mission and supervise tactical/unit operations.

- Communications back to primary position should be confined to essential messages, (i.e., reporting significant events, situation status summaries, resource shortfalls/requests and when the objective is accomplished).

- Position Leader should maintain a unit log including times of operation, significant events, equipment used, and names of personnel in team/unit.

- When ordered by Incident Commander, all incident operations will be secured and response agency personnel will be demobilized via formal termination procedures.

Summary: Know the Incident Command System!

The Shipyard Incident Commander must have a basic understanding of the Incident Command System in order to function efficiently within the system. It is important to remember that the hazardous materials group will be responsible for activities within the control zone. All activities outside the control zones, such as evacuation, will be the responsibility of other elements within the command structures. Using the Incident Command System facilitates safe and efficient operations. The Shipyard Incident Commander should always be able to answer the following questions:

- Who is ultimately "In Charge" of the System?
- What is the Incident Commander’s initial role in the system regarding the Command?
- Where will the Shipyard Incident Commander eventually fit into the overall System?
- Who do Shipyard Incident Commanders report to and communicate within the System?

Session 3. Managing HazMat Events and Agency Coordination

Managing an actual hazardous substance event is very different from exercises and emergency response planning. Actual events are the responsibility of the Incident Commander. In many cases there is difficulty in applying emergency response theory to reality. The most common difficulties are management problems. Incident commanders must be aware of these problems and be ready to apply practical solutions. One of the best solutions is the ability to learn from others who are more experienced. This session of the training discusses what it takes to be a good Incident Commander and provide for agency coordination.

HazMat Incident Commander's Key Role:

The key role of the Incident Commander is to safely and competently manage the incident. This includes all operational aspects and all support activities.

The Incident Commander must respond:

- Safely
- Slowly
- Methodically

Incident Commanders Goals Of The Response:

- Save lives and limit casualties (safety to all, including responders!)
- Protect the environment (air, water, and land)
- Limit damage to shipyard property (buildings and equipment)
- Restore area to normal as soon as possible (resume operations)

The Shipyard Incident Commander Must Be Part of the Solution, Not The Problem, by Knowing the Shipyard Emergency Response Limits!!

The Ideal Incident Commander has "Command Presence"

Through experience with hazardous incidents, it has been determined that the ideal incident commander will be:

- Composed
- Patient
- Comprehensive
- Concise
- Objective
- Organized
- Logical
- Confident
- Professional

The Incident Commander must have training and an intuitive ability to perform effective Decision Making and Problem Solving as described below:

- Decision Making is the process of choosing a course of action.
- Problem Solving is reducing actual situation to a desired situation.

Decision making must be a blend of common sense, safety, predetermined priorities and recognized good practices. The Incident Commander must be able to:

- Mentally focus on the total situation at hand (facts, probabilities, etc.)
- Prioritize life safety factors and take a methodical approach to a desired end
- Avoid over-reacting and giving orders prematurely
- Be objective and focused even when problems are confusing and contradictory
- Use plans, maps, guides, plans, notes etc. rather than relying on memory
- Prioritize the problems and know the “real” resource capabilities present
- Be professional - Do not shout or create a sense of urgency
- Delegate and adhere to the chain of command
- Monitor progress and be alert to modifying conditions
- Maintain poise, do not be afraid to admit error, regroup, and recover

Another important quality is the ability to understand incident command management practices. The Incident Commander should thoroughly understand:

- Macro vs. Micro Management,
- Strategy vs. Tactics,
- Operational vs. Support Control Objectives (including priorities), and
- Delegation of Authority vs. Responsibility.

"Micro" vs. "Macro" Manager:
Micro = small, simple event (few functions/resources)
Macro = large, complex event (many functions/resources)

Definition of Emergency Management:
Management = Directing and Accomplishing work through the assistance of others.

Emergency Management = Making the most efficient and effective use of available resources to minimize impacts of *an* emergency on life, environment and property.

Remember: Be a flexible decision maker and solve the problem.

- Do not forget teamwork, cooperation, and interpersonal skills.
- The primary role of the Incident Commander is to be a safe and competent MANAGER!
- Manager = person or persons charged with the control or direction of resources to accomplish a goal or mission. A Manager is there to Manage and is no longer a worker.

Key tasks of Emergency Management (P.O.L.E.R. & S.D.):

1) P.O.L.E.R

Planning
Organizing
Leading
Evaluating
Reporting

2) S. and D.

Safety
Delegation

The Incident Commander can use the "5 A's" acronym (Arrive; Assess; Action Plan; Assign & Adjust), or a checklist to tie together many key points of Command and Scene Management.

Five Strategic Periods Acronym (5 A's) Checklist	
Arrive	Establish command Establish an Incident Command Post "S.I.N." (Safety, Isolation and Notification)
Assess	Initial organization Initial actions Hazard identification and Assessment
Action Plan	Ensure appropriate planning process Establish strategic objectives for the "Incident Action Plan". Approve "Site Safety Plan"
Assign	Give formal assignments via briefing Provide support to carry out assignments Establish communication links
Adjust	Monitor activities via good communications Do strategic decision making/problem solving Consider next operational period and/or clean-up

Use a Decision Making/Problem Solving model and remember that the Incident Commander is a decision maker and problem solver!

Incident Commander is responsible for managing:

- All operational activities
- All support activities
- The welfare of all personnel

The "Experienced Practitioner" Incident Commander (No Substitute for Experience)

It is helpful to learn from experienced Incident Commanders so that typical management problems on-scene are not repeated. It is a good idea to network with experienced/practitioner Incident Commander's in your area.

Theory vs. Practice (As applied to emergency response)

- Sometimes theory doesn't hold up during actual hazardous substance incidents.
- Compare "Theory" in notebook vs. "Actual Practice" in field.
- Blend theory, laws and safety with common sense.

Thirteen Rules For Hazardous Materials Command Survival (Lessons Learned)

1. Establish command immediately.
2. Establish site control zones quickly.
3. Direct/supervise all responding resources.
4. Obtain, consider, and use situation and hazard data.
5. Unify command with appropriate agencies (Law Enforcement/Fire/Health/Environmental).

6. Rely on hazardous material personnel - but review their work.
7. Develop written objectives and communicate them.
8. Demand adherence to OSHA rules and a completed Site Safety Plan prior to committing personnel to hazardous areas.
9. Inspect and follow-up on Site Safety Plan compliance and Incident Objectives Don't be afraid to admit your limitations.
10. Notify and coordinate involvement of appropriate agencies and individuals. Manager their incident participation.
11. Be involved in securing incident finances, make sure the bill is going where it belongs.
12. Formally transfer the command to appropriate agencies at the end of the emergency phase.
13. Be suspicious of quick fixes and easy solutions.

The Seven Basic Requirements of Incident Command Operations

The seven basic requirements of incident command operations are essential for proper incident command because they ensure safety and minimize environmental impact.

1. Identify all hazardous substances or conditions present at the incident.
2. Based on identification and hazard assessment, implement appropriate operations, and ensure use of proper personal protective equipment (PPE).
3. Ensure that personnel wear supplied air respirators when exposed to inhalation hazards.
4. Limit the number of personnel on-site and always use the “Buddy System”.
5. Ensure that back-ups and standby emergency Medical Systems are available at all times.
6. Designate a "Safety Official" with knowledge of safe operations for the HazMat response .
7. Implement appropriate decontamination from start to finish.

Managing Actual Hazardous Substance Incidents (More Lessons Learned)

Throughout the years, there have been common Incident Command management problems. Many of these problems stem from one of the Incident Commanders "Experiences" in managing The lessons learned from these management problems can be applied to shipyard Incident Commander operations. An experienced Incident Commander will be proficient in the following:

- Approach, recognition and personnel safety
- Isolation/Perimeters
- Notifications and resources; Command Posts
- Command or Scene Management System at Command Post
- Identification, assessment and action planning
- Protective equipment
- Containment and control
- Protective actions
- Decontamination an cleanup, disposal, documentation and reporting
- Agency coordination, planning, media, investigations, etc.

Open Forum For Lessons Learned

The Incident Commander must always anticipate management problems. In addition, potential solutions to those management problems that worked best in past hazardous substance incidents will be better understood. A good incident briefing/critique is a valuable tool for identifying strengths and areas to improve. Networking with experienced HazMat Incident Commander's in the local area, or within the same industry, is another excellent method of learning from others without facing the negative consequences that may be associated with management problems.

The Incident Commander should be able to answer the following response agency coordination questions:

1. What are the key local, state, Federal and private sector agencies that the shipyard Incident Commander will work with?
2. What are the "Roles" of local, state, Federal & private sector agencies that the Shipyard Incident Commander will work with?
3. What are the real response "Capabilities" at the local, state, Federal & private sector within the shipyard response plan?
4. How can the shipyard Incident Commander better coordinate with these local, state and Federal agencies, before, during, and after the hazardous substance incident?
5. How can the shipyard Incident Commander promote and maintain a spirit of interagency cooperation?

Typical First Responder Agencies

- Fire Services (Fire Departments/Districts)
- Law Enforcement Agencies (Police Departments, Highway Patrol, etc.)
- Emergency Medical Services
- Health Agencies (County Health, Environmental Health)
- Public Works Departments (County Engineering, State Transportation, etc.)

Others agencies include: County Office of Emergency Services, Agriculture, Air Pollution Control Districts, Flood/Sanitation Districts.
Local agencies are first line of defense for hazardous substance incidents.

Key State Hazardous Substance Agencies

- Highway Patrol: Incident Command Authority - on state highways for state agency coordination.
- Department of Fish and Game - off-highway incidents that threaten wildlife.
- State Incident Commander for oil spills in marine waters.
- State Office of Emergency Services - focal point for notification of state agencies.
- Other key state agencies: Department of Forestry, State EPA, etc.

Key Federal Hazardous Substance Agencies

- U. S. Environmental Protection Agency (EPA): Federal Oil Spill Control/Inland Zone.
- U. S. Coast Guard (USCG): Federal Oil Spill Control/Coastal Zone. Boundaries of Inland & Coastal zones specified in Regional Contingency Plans.
- Other key federal agencies: DOD, DOE, FEMA, DOJ, etc.

  * DOD is Oil Spill Control for HazMat releases on DOD facilities or vessels.
  * DOD is Oil Spill Control for incidents involving military munitions.
  * DOE is Oil Spill Control for incidents on DOE facilities.
- Federal agencies usually have designated support role as specified by National Contingency Plan (NCP).

HazMat Responsibility Listing

- Incident Commander/Scene Management
- Scene Isolation
- Rescue
- Medical Care
- Coordination (Incident Command Post)
- Containment & Control
- Initial Risk Identification and Assessment
- Communications
- Notification
- Radiological Monitoring
- Hazard Assessment
- Public Information
- Access to Remote Area
- Removal/Pick-up
- Highway Maintenance
- Training-Interagency
- Critique/Follow-up
- Disposal

Terminating Command

At the end of an emergency, it is important to ensure that all OSHA required operations have been successfully concluded. This includes ensuring that life, environment, and property are no longer at risk from the incident. This often means that site clean-up is complete. However, the clean-up phase in a major incident may last for days or even weeks after the conclusion of an emergency. Incidents that transition to the clean-up phase may enter other regulatory areas of OSHA and environmental regulation. Always perform the following as the incident is terminating:

1. Consult with appropriate environmental and health officials when determining the on-going requirements for clean-up.
2. Determine authorities, command decision making, finances, and related issues for the clean-up phase, before terminating the emergency phase, when clean-up activities are protracted.

Terminating the emergency phase is often a joint decision by many organizations (internal or external) that have legal responsibility or other interests for response and clean-up. Some of the issues may determine if sufficient decontamination procedures are in-place or if waste materials have been secured and disposed properly. It is also important when terminating command that, documentation of all incident decisions, activities, and costs are accounted for. This will assist in incident reconciliation, critique, and other affairs.

Summary Incident Management Questions:

At the end of this session, Shipyard Incident Commanders should be able to answer the following questions:

- How does "Managing an Actual Hazardous Substance Event" affect the Incident Commander?
- Is there difficulty in applying theory to reality, when it comes to hazardous substance incidents?
- What are some of the common management problems at a hazardous substance incident?
- Am I aware of the many management problems I will be faced with, for every hazardous substance event in which I am the Incident Commander?
- Am I aware of the practical solutions to many common management problems faced by other Incident Commanders in past hazardous substance events?
- Do I know of experienced hazardous substance Incident Commanders within my area?
- Can I network with those experienced hazardous substance Incident Commanders, for "Practical" management tips?

Session 4. Incident Command Post and Command Organization

One of the most effective methods for enhancing communication and coordination at the scene of a multi-agency incident is the use of a Joint/Unified Command Post. This is known as the "Incident Command Post". The Incident Command Post must be located in a centralized place outside the hazard zone, where other response organizations may interface with the Incident Commander. An Incident Command Post provides for better management, coordination, communication and control of a multi-agency response.

Criteria for establishing an Incident Command Post
It is necessary to establish an Incident Command Post when,

- More than one agency responds to the incident,
- Coordination or joint decision making is required to respond properly to the incident, and
- The event is complex or long lasting (greater than one day).

Incident Command Post Staffing

- The first arriving unit should set up a temporary Incident Command Post.
- The designated Incident Commander will establish a formal Incident Command Post.
- Each response agency will provide a representative at the Incident Command Post with the authority to speak for their agency and commit resources.

Incident Command Post Location

- The Incident Command Post should be located well away from the hazards of the event.
- It is always best to be upwind, uphill & upstream.
- The location must be at the edge of the Support Zone.
- Roadways should be established so that vehicles can be accessed at the Incident Command Post.
- The Incident Command Post location should be clearly designated using flags, cones, signs, green light on vehicles, etc.
- The location should be safe and secure from any potential problems. There should be a plan to relocate the Command Post if a wind shift occurs or when new information spurs the need to move.

Bottom Line - A Coordinated Effective Response Effort Requires An incident Command Post

"Single or Unified" Command

When a single agency or entity will be responsible for all aspects of incident management, one individual with command authority will assume "Single Command". This is a rare situation and usually occurs during a hazardous materials response on highways or large industrial facilities. This is due to many governmental and private jurisdictional concerns. Small incidents in the shipyard may also require a Single Command where the Shipyard Incident Commander communicates with on-site responders and local response contractors.

When multiple agencies or entities all share responsibilities for a given spill response, lead individuals from each response entity will co-locate and operate one "Unified Command". It will have common objectives, pool resources, and speak with one voice. It is not uncommon to have Law Enforcement, Fire, Health, Environmental, and Shipyard representatives all participating in a Unified Command for larger hazardous substance incidents.

HazMat and "Who's In Charge"

The shipyard Incident Commander must assume command early to reduce chaos and aid management. This is the most effective management tool. The Incident Commander should determine if a "Single" or "Unified" Command concept is required..

Manage Command Early By:

- Assuming "Authority Command" formally
- Setting up a Preliminary Incident Command Post
- Managing the event to your capabilities until increased resources and/or a more experienced Incident Commander arrives
- Performing a thorough briefing before transferring command
- Good organization is the key

Critical Components of a Good Organization*:*

- One unified organization
- Clear functional elements (division of labor)
- Flexibility and expandability
- Unity of command (with good supporting chain of command)
- Manageable span of control
- Effective communications and coordination

Information Flow and the Incident Command Post

The incident Command Post is a central communication element that must be established early to help prevent chaos and confusion. It serves as a central point of control. Establish a Command Post as soon as possible using the following guidelines:

1. The first arriving unit should set up a temporary Incident Command Post until the Incident Commander arrives. This is to provide a center for better scene management, coordination, communication and control.
2. The Incident Command Post is required when there is more than one agency, coordination is needed, the event is complex and/or the incident may be long lasting. Each key response agency should provide a person at the Incident Command Post.
3. Locate the Incident Command Post away from scene, but with the ability to communicate within security capabilities. The Command Post should be an area large enough for all involved.
4. Establish a “Staging Area" as a safe haven for assisting agency units to check-in and temporarily hold until assignment is given. Locate the staging area upwind and uphill, within a three minute availability status from all sections.

Incident Command System and the "Communication" Tools

The main purpose of an Incident Command Post is to provide one center for incident management, coordination, control and communication. The shipyard response personnel should set-up the initial Incident Command Post until Incident Commander arrives at the scene. Upon further hazard identification and assessment the Incident Commander may change the location as necessary. It will be located away from the scene, but still able to communicate. The Incident Command Post is the one safe, well marked, location where each key response agency should provide a representative with the authority to speak for their agency and to commit their resources.

Note: Information flows from all sections to the Incident Commander at the Incident Command Post Which acts as the "Hub" for incident communications!

Keep Communications Clear And Essential:

- The Incident Commander may need to establish a Communications Unit.
- The Incident Commander may need a communication plan with specific communication networks.
- All written reports and documentation will flow through the Incident Command Post.
- Written documents will be clearly printed.

Essential Communications Include:

- When the mission is accomplished,
- When more resources are needed,
- When an extraordinary situation occurs, and
- When giving a situation update.

All Essential communications should flow through the Incident Commander and Incident Command Post.

Session 5. Toxicology and Hazard Identification Risk Analysis

The Incident Commander has received a lot of training and education on toxicology, hazardous materials identification and hazard/risk analysis. He/she must have this basic understanding in order to determine the proper protective equipment, and to identify an action to minimize hazardous exposure to employees, the public, and responders. The focus of this Incident Commander lesson is based on the following incident management questions:

- How does "Toxicology" affect the Incident Commander and their responders?
- Should the Incident Commander send someone into the hazard area to do something that they would not do?
- Is there an ethical or legal responsibility to minimize exposure to all responders?
- What does "Managing with Minimal Exposure" mean to the Incident Commander?
- How does identification and hazard assessment affect the Incident Commander?
- How can the Incident Commander get "Intelligence" vs. "Information" on HazMats?
- What is the "Baseline" question for identification and hazard assessment?
- Can the Incident Commander develop a good Incident Action Plan, with solid objectives & strategy?
- What should the Incident Commander look for in a good site safety tactical plan checklist?
- What factors are involved with a Risk vs. Gain approach?

The Incident Commander s Role in Understanding Toxicology and Health Effects

It is important that the Incident Commander understand the basic concepts of toxicology. It is their responsibility to maintain a safe work environment during an emergency response. This if a difficult task considering the nature of hazardous materials incident. The following points must be emphasized when an individual becomes an Incident Commander:

- Toxic effects can be related to Victims and/or response personnel an their life and health!
- Many deaths and injuries may happen to exposed responders.
- Consider short and long term health effects from exposure!
- Toxicology is a deadly important subject!
- Understand the nature of the chemicals at hand before problems occur. If the Incident Commander does not have proper chemical information, the result may be deadly.
- Limit the number of personnel in toxic areas of potential or actual exposure.

Personal Goals of Every Incident Commander and HazMat Responder

The Incident Commander has several goals associated with a hazardous substance incident. However, the Number One Goal is that *Everybody Stays Alive!* The Incident Commander should limit exposure to the fewest responders and employees through the Control Zones and restrict the number of responders in the Exclusion Zone. Protect Yourself & the People you work with!

Bottom-line:

The Incident Commander has an ethical responsibility to protect responders by keeping the fewest number of responders with the best PPE in the Exclusion Zone for the shortest amount of time. In other words: Manage the incident with minimal exposure!

The Incident Commander Must Always Remember:

- Responders are often Victims - Primarily by Inhalation.
- Understand that acute effects may not be visible and exposure can be cumulative.
- Both Chronic (long term) and Acute (short term) Exposures can cause Death and Injury to Response Personnel. (Note: Acute effects may not show up immediately. Some acute effects may not manifest themselves for hours or even days.)
- Know Toxicology Resources (e.g. Poison Control Centers).
- Do Not Forget About Responder Exposure Records.

Managing to Minimize Exposure

"The individual in charge of the incident shall limit the number of emergency response personnel at the emergency site, in those areas of potential or actual exposure to incident or site hazards, to those who are actively performing emergency operations."

- Inhalation hazards require approaching the scene from upwind.
- Establish control zones as soon as possible.
- Require all entry teams to wear supplied air when necessary or when hazards are unidentified.
- Evaluate potential vapor/gas dispersion and consider the possibility of shifting wind directions.
- Always apply proper decontamination of all exposed personnel, victims, and equipment.

Identification and Hazard Assessment and the 5 Step Process

One of the most critical aspects of a hazardous materials response is "identification and hazard assessment". The Incident Commander must recognize that It can be a long and complex process. The Incident Commander, with assistance from HazMat Technicians and Specialists, must perform an assessment to identify all hazardous substances or conditions present at the scene. An Incident Commander cannot manage a hazardous incident if they cannot identify and assess the problem correctly.

Identification and Hazard Assessment

Without Hazard Assessment, Identification means nothing!

Priorities: First identify the chemical then assess:

- General, Health and Fire Hazards
- Physical and Chemical Properties
- Variables and Modifying Conditions
- Behavior and Outcomes

Risk Assessment Measures Impacts:

- Protective clothing and Equipment
- Containment and Control Methods
- Protective Action Options
- Medical Aid, Decontamination and Clean-Up Procedures

The 5 Step Process for Basic Identification and Hazard/Risk Assessment.

1. Identify chemical name
2. Assess all hazards
3. Assess physical, chemical and toxicological properties
4. Assess variables/modifying conditions
5. Predict behavior/outcome

Information Sources:
Information sources are the key to proper identification and assessment. Understanding how to find information is required. Here are a few sources:

- MSDS (i.e., Material Safety Data Sheets for a chemical)
- Placards and labels (i.e., colors and symbols)
- Shipping papers (i.e., Bill of Lading, Way Bill, Etc.)
- Reference guides (i.e., NA Emergency Response Guidebook)
- Technical information centers (i.e., CHEMTREC) etc.
- NFPA 704 Diamond Sign Warning System
- Computer data bases (i.e., CAMEO, TOMES, HIT, etc.)
- Pesticide labeling (i.e., Danger, Warning & Caution signal words)
- Pipeline markers (i.e., product, owner & emergency number)
- Three information sources preferred minimum for identification and hazard assessment

First responders must be aware of the 1996 North American Emergency Response Guidebook ("NAERG96"). The NAERG96 is a safety tool for basic identification, assessment and initial response and recognized as good practice/standard for first responders to follow. The current version of the NAERG should always be used for transportation-related HazMat incidents! Similarly, use current MSDS for incidents at shipyard facilities.

Other Identification and Hazard Assessment reference guides:

- Condensed Chemical Dictionary
- CHRIS Manual
- NIOSH Pocket Guide to Chemical Hazards
- Dangerous Properties of Industrial Chemicals
- Farm Chemical Handbook
- NFPA Fire Protection Guide to Hazardous Materials
- Merck Index
- Computer databases

Key Risk Variables For Identifying Conditions and Hazard Assessment Issues

The same material with different variables may significantly change the incident and the way the incident is managed. The Incident Commander will not find these variables and the appropriate management practice in any "Book of Answers." Therefore, the Incident Commander must use their own judgment to make logical conclusions and exercise the best management solutions. Many variables will impact the hazard assessment and must be taken into account, such as:

- Location (i.e., office area, production area, storage area, near waters, etc.)
- Time/date (i.e., evening or day, business hours next to a school, lunch hour, etc.)
- Weather (i.e., wind, temperature, rain-actual or forecast, etc.)
- Nature of materials (i.e., household bleach, liquid chlorine, oil, etc.)

- Stage of incident (i.e., initial stage of release, empty tank, releases to waters, injuries, etc.)
- Size of problem (i.e., potential amount, release rate, number of casualties, etc.)
- Type, condition, nature and behavior of container (i.e., round, rolling, glass, major damage, etc.)
- Amount, type and training of responders and equipment (i.e., Operational, HazMat Technicians, etc.)
- Availability, type and amount of control agents (i.e., spill clean-up supplies, on-hand, insufficient, etc.)

Predicted Behavior and Baseline Questions Help to Gather Intelligence

Before intervention, try to predict the behavior of the release. Think about the potential outcome of "natural stabilization". *Ask the following two baseline question:*

- What if I did nothing?
- What favorable impact will intervention make?

The Incident Commander may need a chemist, technical specialist, industrial hygienist or HazMat team, for complex incidents, multiple hazards, radioactive materials or "Mixed Bag" problems to aid in identification, hazard assessment, hazard categorization, and/or action planning. The end result of identification and hazard assessment is "*Intelligence*," which is based on "*information."*
Intelligence is considered to be information that is:

- Verified
- Organized
- Analyzed
- Prioritized
- Made Useful

If you have identification and hazard assessment intelligence, you are ready for action planning.

The Safe and Competent HazMat Process

There is a need to perform basic "Processes" during hazardous substance identification and risk analysis. Remember that a "Process" is much like a procedure and can help the Incident Commander manage any and all HazMat events. Following guidelines, procedures, and processes will help the Incident Commander meet the goals of a HazMat Response, which are to protect:

- **Life/Health**
- **Environment**
- **Property**

A Sample Process: The 12 Essential Steps For Tactical Operations

1. Safety
2. Isolate and Deny Entry
3. Notifications
4. Command
5. Identification and Hazard Assessment
6. Action Planning
7. Protective Equipment

8. Containment and Control
9. Protective Actions
10. Decontamination and Cleanup
11. Disposal
12. Documentation

A "Checklists" Helps Identify the Process

Checklists are excellent tools for the Incident Commander and other HazMat Responders. Examples are a position checklist, a chemical identification checklist, or a generic Incident Commander procedural checklist as follows:

When Arriving At The Scene:

1. Approach upwind, upgrade and upstream from a safe distance.
2. Stop at a visual sighting area and use binoculars to perform a preliminary site evaluation.
3. Position the response vehicle headed away from the event and not too close to the hot zone. If possible, use your vehicle to help isolate incident (block routes of entry).
4. Make notifications and request resources and provide safe routes of entry for responders.
5. Maintain position in safe area and institute an Incident Command Post.
6. Establish formal command, verbally, visually and firmly (i.e., take charge).

When Assessing The Scene:

1. Get a briefing from first responders (Awareness Level, Operational Level or Technicians) at the scene.
2. Assess initial actions by responders and accept information as only a preliminary source.
3. Conduct a full hazard identification and assessment and delegate a central focal point of investigations.
4. Until the complete identification and hazard assessment is determined, organize resources based on the information that exists.
5. Perform rescue operations if the gain outweighs the risk.
6. Take defensive actions like containment, if it is safe to do so, within your level of resources

When Action Planning At The Scene:

1. After complete identification and hazard assessment, perform a planning meeting and develop a written Incident Action Plan (consistent with the Site Safety Plan).
2. Do not underestimate potential problems. Expect problems and always anticipate the best reaction to predicted problems.
3. Ensure all personnel have appropriate protective equipment for the control zone.
4. Do not forget decontamination procedures and enforce decontamination objectives.

When Assigning At The Scene:

1. Communicate Action Plan through an incident briefing.
2. Assign Incident Action Plan leader positions to ensure safe and proper incident command.
3. Ensure that everybody observes clearly defined physical control. Limit the number of personnel in the control zones to the resources required.
4. Always use the "Buddy System" with back-up people for potential rescue and assistance.
5. Ensure the Emergency Medical System is on-scene and is prepared for casualties.

When Adjusting At The Scene:

1. Monitor the overall management of the incident and expected problems. Communicate adjustments as needed to the management of the event.

2. Think ahead to the next operational period (i.e., clean-up processes)
3. Perform proper disposal or all incident related waste. Understand that wash-water from clean-up or decontamination that flows down drains may cause a serious environmental problem.
4. Keep good documentation and exposure records through the delegation of this responsibility.
5. Always use teamwork as an essential element to coordinate with all responders.

Checklists are "mind joggers" that can help ensure safety and increase management control. The Incident Commander is encouraged to develop their own set of checklists to help ensure that all of their responsibilities are met.

Risk vs. Gain Analysis as a Process:

Incident Commanders must understand and prioritize the goals of response. This requires the Incident Commander to mentally conduct a Risk vs. Gain analysis before assigning tactical operations for responders at a HazMat incident. The follow items list the Risk vs. Gain concerns:

1. Identify responder, employee, public life, environmental, and shipyard property **Gains**
2. Identify responder, employee, public life, environmental, and shipyard property **Risks**
3. Assess the required level, resources, and capabilities of available responders
4. Consider the overall safety factors associated with the actions to be taken
5. Consider the viability and reasonable outcomes of the action to be taken

Risk vs. Gain is mainly driven by responder safety and tempered by common sense and response experience. If Risk outweighs Gain, maintain distance and protect the public, employees and the responders. Only if Gain outweighs Risk, should action be taken. Decisions to take offensive actions (Risks) are not easy. A careful and well thought out process will ensure a disciplined approach.

For Example: Pros and Cons of Rescue in Exclusion Zone
Dilemma: To rescue or not to rescue. Are the probabilities of responder and victim survival high.
Pro: Public safety responders job is to rescue people in danger. A life could be saved and injury can be reduced.
Cons: Need to think about responders life, equipment, buddy system, other factors that may lead to a rescue failure.

The same Pros/Cons and Risk vs. Gain assessment can be used to limit environmental and property damage. The Risk vs. Gain will be a mental process directing any operations at the HazMat Incident.

Understand, Non Intervention is always a possible strategy if:

- No life is in danger
- Resources and capabilities are not adequate
- Where risk outweighs gain!!!

Session 6. Incident Response Planning

HazMat incidents usually happen unexpectedly and require immediate attention. When an emergency occurs, decisive actions must be taken quickly to limit the severity of the incident. Personnel and equipment must be readily available to respond in a moments notice, upon direction of the Incident Commander. Planning, in combination with an incident command system, will ensure the effectiveness of response actions. Shipyards are required to develop and implement emergency response plans, which are documents that detail the specific response actions to be initiated in the event of a hazardous substance spill or emergency. Developing and implementing incident planning requires good a "team" planning process. This will provide for good response outcomes, The following are ideas to keep in mind:

- "The Plan is Nothing - To Plan is Everything!" George Marshall.
- A direct relationship exists between a good planning process and an effective response.
- A good Incident Commander is a good "team" planner.

The Incident Commander Should Have An Active involvement in Emergency Planning

Good planning by the Incident Commander and others in the shipyard will help eliminate unknowns, clarify roles and responsibilities and enhance coordination which, ultimately, makes response more efficient, effective and safe. Emergency response plans are very important documents that will take several weeks to develop. They will be modified as processes and facilities in the shipyard change. Emergency response plans encompass information from nearly all areas of the shipyard and can affect nearly all departments. Utilizing a variety of departments and personnel in the planning process will give employees a sense of ownership in the plan. When all personnel are involved in it's development, it becomes a "living document" that employees are more likely to understand and use. The team planning process, utilizing the principles of Total Quality Management (TQM), includes using the following resources in it's development:

- Any and all agencies and internal departments, with a mandated role in the planned response, should participate in the development of the emergency response plan.
- Support and involvement from the following shipyard departments or functional groups:
  - Security, Environmental, Health & Safety, On-Site Fire and Medical Departments
  - Operations - Managers and Supervisors (ship repair and new construction)
  - Maintenance - Supervisors, Lead Foreman
  - Facilities - Engineers and Assistants
  - Engineering - Chemical, Mechanical, or Environmental
- Support from Public Agencies that would provide emergency services during a hazardous materials incident including, Police, Fire, Local Hospitals, Ambulance Services, etc.
- Support from the Local Office of Emergency Services.

The team planning process is as important, if not more so, as the plan document itself. Planning done in a vacuum will fail whereas people and groups help support that which they create. The Incident Commander should not be afraid to "Brainstorm" alternate strategies with his/her Command and General Staff, or key agency representatives. Unified command and planning process will contribute to a joint team plan and lead to more organized and efficient responses. The Incident Commander is tasked to get a good plan together and get continual and enthusiastic team involvement during the planning process. The basic steps in the process include:

- Select planning team

- Do a hazard analysis
- Do a resource capability assessment (identify resources)
- Identify agency roles and responsibilities
- Draft the plan concept of operation and checklists
- Conduct training and exercising on the plan
- Review and update the plan

Key Components Include:

1. Valid threat summary/problem identification/hazard analysis
2. Useable resource list
3. Clear roles and responsibilities
4. One operational organization/scene management system
5. Procedures to establish joint Incident Command Post
6. Operational checklists

Goals of Emergency Planning

The ultimate goals of the shipyards hazardous materials response should be prioritized and stated in the plan. The goals and priorities should generally take the following order:

1. **Life and health** - First consideration to responders, persons needing rescue, other employees.
2. **Environment** - Actions taken need to consider potential environmental releases before property.
3. **Property** - Protection of shipyard property is important, although last priority.

It is important to understand the general purpose of planning. Planning is an important part of the response plan itself. The emergency response plan is the end result of the emergency response process of planning. The process of planning for hazardous incidents represents a first step toward an effective response. The four basic steps of shipyard emergency planning development are:

Step 1. Identify all potential hazardous materials dangers on-site, from handling and storage, to processing.

Step 2. Identify all available and required resources, from within the company and outside, through mutual aid agreements or private contractors.

Step 3. Determine training and equipment needs necessary to develop in-house emergency response capabilities.

Step 4. Validate the plan by conducting emergency response exercises. Start with table top exercises, then partial-functional exercises, and graduate to full scale exercises involving the public agencies.

Emergency Planning Objectives

There are four main objectives to consider in shipyard emergency response planning:

1. **Preparedness:** Once the plan is developed, it must be continually reviewed and updated, trained to, and exercised.
2. **Response:** Implementation of the incident action plan.
3. **Mitigation:** Methods used to contain or control the release. Some companies have developed standard operating procedures to control releases or shutdown a process. The later is known as emergency shut-down procedures.

4. **Recovery:** The process of restoring a production area or bringing a process back on line. Recovery may include decontamination of the affected area and proper disposal of wastes. An investigation of the incident to determine root cause should be conducted prior to repairing equipment or rebuilding a process area.

Planning Process Benefits

The ultimate value and benefits of good planning puts responders in a proactive, rather than a reactive, response mode. A reactive response will be unorganized and may result in miscommunication and injury to employees and responders. The specific value and benefits of planning generally include:

Benefits	Description
Proactive Response	Reduces the time spent reacting to a crisis and makes better use of time, preventing an increased crisis.
Incident Prevention	Reduces risks by eliminating, or reducing, conditions which may cause an incident.
Hazard Analysis	A process that identifies hazards and evaluates risks. The goal is to eliminate the unknowns and institute "In-Control" management.
Encourages Involvement	Includes personnel from within the company and companies or agencies that may respond to an emergency. The results are buy-in for the plan from company personnel and establishing a positive relationship with the community, and local, state and Federal agencies.
Contingency Assessment	Evaluates personnel, equipment, and training needs. The pre-plan should consider the responders level of training, resources, and capabilities. Are they adequate for the shipyard facility conditions?
Incident Management	Good management personnel and systems are important to the successful conclusion of any incident.

Incident Commanders Must Know Their HazMat Plans!

As described in OSHA regulations the Incident Commander must be knowledgeable about their facility Pre-Event Plans. The regulations dictate that the Incident Commander must:

- Know how to implement employers emergency response plan
- Know their Role
- Know their Responsibilities
- Know Standard Operation Procedures (SOP's)
- Know Scene Management System (Incident Commander System)
- Know how to implement local emergency response plan.
- Be aware of the State HazMat Plan.
- Be aware of the Federal Regional Response Teams.

Two General "Types" of Plans

There are essentially two types of hazardous substance emergency planning required by state and federal laws. The two types of plans are very important for an efficient and safe response to hazardous substance emergencies. The two types of plans include the Pre-Event Plans (shipyard facility specific) and Event-Specific Plans (pertain to a specific emergency response). Pre-event

emergency plans can take several months to develop and are an excellent tool, if developed properly. On the other hand, in developing event-specific plans, time is of the essence and an efficient process is essential. Both types of plans have their own set of pros and cons. The Incident Commander will need both plans in order to effectively manage shipyard hazardous incident responses.

Pre-Event Plans:

Emergency Action Plans
Many states require the employer to develop an emergency action plan to protect employees in the event of a release of hazardous materials and/or fire. These action plans usually contain evacuation routes, major emergency procedures, and community involvement.

Emergency Response Plans
The emergency response plans are developed and implemented to handle anticipated emergencies prior to the emergency. These plans may be required if employees are expected to respond as a team. These plans can include Hazardous Materials Business Plans, Spill Prevention Control and Countermeasure Plans (SPCC), Adverse Weather Plans, Vessel Spill Response Plans, and a variety of other plans that may be required by local, state, and Federal regulations. Elements of the emergency response plans will include:

- Pre-emergency planning and coordination with outside parties. Personnel roles, lines of authority, training and communication.
- Emergency recognition and prevention.
- Safe distances and places of refuge.
- Site security and control.
- Evacuation routes and procedures.
- Decontamination.
- Emergency medical treatment and first aid.
- Emergency alerting and response procedures.
- Critique of response and follow-up.
- PPE and emergency equipment.
- "Emergency response organizations may use the local emergency response plan, the state emergency response plan, or both, as part of their emergency response plan to avoid duplication."

Event-Specific Plans:

Incident Action Plans
The "Incident Action Plan" identifies the specific "Problem," all available "Resources" and then makes best use of all "Resources" to minimize the overall impact of the "Problem" on life, the environment & property. The Incident Action Plan is based on objectives, and is usually developed by the Incident Commander and HazMat Technician Responder to provide the strategic objectives. Therefore, it is a "strategic" document that outlines broad incident management goals or objectives. This document identifies the incident's organization, resources, and assignments. It is common to stipulate communication, medical coordination, and specialty resource management issues in this plan.

The Incident Action Plan must be implemented during the emergency within the capabilities of available personnel and equipment. The plan is broad based and a strategic tool for managing the

emergency and achieving desired results. It defines the problems involved and accesses the resources available to solve the problem. The objective should be measurable, but allow for technical staff to maintain some freedom to accomplish the objective using the best method or tactics possible. This plan is global, in that it involves a variety of hazards, including potential environmental releases. This plan should be in writing if the incident is large. Otherwise, it may be incorporated into the site safety plan.

Key Components of an Incident Action Plan Include:
1. Clear Problem Identification & Hazard Assessment/Analysis
2. Clear Control Strategic General Objectives
3. Clear Assignments per Incident Commander System position/organization
4. General Safety Message
5. Other (i.e., weather, communications plan, medical plan, etc.)

An Incident Action Plan should be written if:
1. The Incident involves resources from multi-agencies,
2. The Incident is multi-jurisdictional,
3. The Incident is longer than one operational period,
4. Or it is desirable for documentation that the plan be written; etc.

Site Safety Plans

A Site Safety Plan is for all activities conducted in the control zones (especially the Exclusion Zone). It is developed to ensure the health and safety of all personnel involved in response activities at the site. It must be in writing, identifying all known and suspected hazards and communicated to all personnel prior the commencement of response activities in the control zones. The development of the site safety plan is performed by the Incident Commander with assistance from HazMat Technicians. The Site Safety Plan can be described as follows:

- A "tactical" document that details specifics and methods for accomplishing incident objectives. This is a technical document that requires the input of trained individuals.
- Federal OSHA regulations require that only an Incident Action Plan be developed. However, some state OSHA regulations require both an Incident Action Plan and a Site Safety Plan.
- Priorities have been established by law for the management of hazardous materials incidents. They include, in order: Life, Environment, Property.
- Site Safety Plans should be developed with the assistance of hazardous materials Technicians or Specialists, when possible. The Incident Commander has a responsibility to review and approve these plans.

The Site Safety Plan should include:
- A risk or hazard analysis for each site task
- Employee training assignments
- Personal protective equipment to be used
- Medical surveillance requirements
- Frequency and types of air monitoring, personnel monitoring and environmental sampling
- Site control measures
- Decontamination procedures
- An emergency response plan
- Confined space entry procedures.
- A spill containment program

Issues that should be addressed by a Site Safety Plan include:

- Safety and risk analysis
- OSHA training standards and responder certification
- Personal Protective Equipment use
- OSHA medical Program
- Air monitoring program
- Site control
- Decontamination practices
- Emergency contingencies
- Confined space entry (if applicable)
- Spill management techniques
- Spill characterization
- Command organization

Compliance with OSHA requirements is accomplished through effective development and implementation of the Incident Action Plan and Site Safety Plan. Skill and competency of workers in carrying out these plans is also evaluated.

Note: Event-specific planning procedures and processes are usually outlined in the Pre-event emergency response plans.

Session 7. Hazardous Incident Containment, Control, and Isolation Strategies

The specific actions taken in response to a spill or release will vary due to the diversity of potentially hazardous situations in shipyards. The hazards of the material, the location, the weather, and the amount spilled substance involved, will affect the response scenario. Due to the complexities surrounding the selection of a response procedure for specific emergency situations, this session will address a general response sequence that can be applied to shipyard hazardous substance incidents.

Upon discovery of a spill or fire situation, the initial examination will provide important information to responding personnel. Identification of what happened, where it happened, to whom it happened, when it happened, the extent of damage and what aid was needed, must be included in the report to the incident communication system. Once response personnel receive this information, an evaluation will be made as to the proper response procedures to be employed by the response organization. A good emergency response plan *details* response actions, that are specific to the shipyard materials, equipment, facility layout, and response personnel. The following outlined sections (A - F) provide the basis for emergency response planning:

A. **Rescue:** In the event of an emergency, rescue of injured personnel is one of the first priorities. Ensure that responders properly protect themselves. Unless you know the specific hazards, use at least EPA Level-B protective gear (including chemical resistance coveralls and SCBA), and remove victims from the immediate spill/fire area as soon as possible.

B. **Alert:** Notification of the emergency should be undertaken as outlined in the facility emergency contingency plan. For example, In fire situations, this includes pulling the fire alarm or calling the fire department as soon as possible. In a spill, the procedure may also include notifying the fire department (if their responsibilities include spill response), or the on-site response.

C. **Assessment:** It is vital to determine what chemicals are present and their hazards in order to apply the appropriate levels of protection, as well as address several other safety and emergency response concerns.

D. **Contain:** Immediate containment of a spill or fire is a high priority. Containment will minimize the exposure of personnel to dangerous materials or life threatening fires. Containment will also enhance the chances of recovering useable material and minimize the total time and cost associated with final clean-up. The specific circumstances and extent of an emergency will dictate the timing and response actions taken to contain a spill.

E. **Evacuate:** Evacuation is the removal of non-essential personnel from specified areas. Depending on the circumstances of the spill, release, or fire, evacuation may include the immediate vicinity, adjacent areas and buildings and off-site areas. The decision to evacuate is made by the Incident Commander. Upon announcement, personnel should immediately leave the area by the designated evacuation routes and meet at specific points outside the affected area.

F. **Cleanup:** A wide variety of cleanup techniques are available. However, the choice will be dictated by the substance spilled as well as the containment techniques applied. Cleanup may require a combination of several different techniques. In addition to deciding what

techniques are appropriate, cleanup personnel must determine when the cleanup process should begin and what level of cleanliness determines completion.

Immediate Actions:
The immediate actions of all employees, of any company or shipyard, in the event of a chemical spill or gas release must be understood before an incident occurs. The immediate actions are:

1. Clear the area
2. Check for personal involved
3. Isolate the spill (if safe to do so)
4. Perform emergency response

The primary objective of any shipyards management team and/or employees during an emergency response, should be to protect the health and safety of all employees, contractors and visitors. No action should be taken during an emergency response that directly, or indirectly, violates this principle. An evacuation of the building should be initiated if one of the following conditions occurs:

- **Uncontrolled Open Flame**
- **Uncontrolled Compressed Gas Release**
- **Any Situation that Poses an Immediate Threat to Human Health or Safety**

When an evacuation alarm sounds, all workers within the affected building(s), MUST immediately exit the building and report to their assigned evacuation stations. In the absence of such direction, if a threat to their personal safety or well-being is perceived, employees are urged to leave the affected area of their own volition. Any attempt to stop or control the source of a release or eliminate potential sources of ignition shall be performed only if it can be accomplished without personal risk, during normal evacuation procedures.

Offensive control and containment options are reserved for the Incident Commander due to their specialized training and experience. The Incident Commander may be called upon to *decide* which chemical protective equipment is best to protect the entry responders. Understanding containment and confinement controls, and safe work practices, during an incident will help the Incident Commander make these critical decisions. Careful planning is the key to safely and effectively containing any release. Hazardous materials spills/releases should be contained as quickly as possible to eliminate or reduce the hazard, prevent contamination of people and the environment, and to facilitate clean-up.

Actions by the Incident Commander should contribute to solution, not problem!
Remember the following two primary baseline questions:

- What if I didn't intervene?
- Will your intervention help?

The Incident Commander has 3 Basic "Strategies" to Stabilize A HazMat Incident:
1. Non-Intervention: No direct actions, other than Safety and Isolation
2. Defensive/Contain: Slows & restricts HazMat spread
3. Offensive/Control: Stops HazMat release (Incident Commanders)

There are Many Ways to Determine a Strategy:
Move from No Fight, to Defensive, to Offensive when level, resources & capabilities of responders are in line with strategy. For example:

- Problem vs. Resources + PPE = Strategy
- Safety + Common Sense = Strategy

Non-Intervention Strategy

Non-Intervention is when no direct action is taken to stop, slow, contain, or restrict a release.

When Should The Incident Commander Apply Non-Intervention?

- When it is Unsafe!
- When There is No Substantial threat to Life or Health!
- When There is a Lack Response Resources!
- When There is a Lack Proper Personal Protective Equipment!

Responders Are Tasked To Save Lives And Not Risk Lives Unnecessarily!

The Objectives of Non-Intervention or Isolation

The typical "methods" of non-intervention

- Isolate the area, deny entry, and make proper notifications.
- Make an effort for Spill Retention (i.e., let the spill collect in natural low area or sump)

How to Control Entry Points

- Visually determine isolation distance for the "Inner Perimeter" (Consider 2-3 times larger distance downwind.)
- Identify closest entry/control points for the "Outer Perimeter" (doorways, intersections, gates, etc.)
- Start with primary & safest outer perimeter entry point.
- Make early request for sufficient units to secure entry points. (Law Enforcement or Auxiliary Units) Give locations and safe routes for ingress.
- Use manned vehicles, barricades, cones, etc.
- Identify staging areas for responders.

Hazard Control Around the Hazard

- Secure the area around the Outer Perimeter.
- Use tape, natural barriers, patrols, etc.
- If more space is needed, expand the outer perimeter to the most practical distant access point (i.e., main gate, major artery intersections, etc.).

Perimeter Control Access, Inside the Perimeters

- Keep the public and nonessential responders out of immediate area.
- Maintain patrol of Outer Perimeter area.
- Provide security for Support Zone work areas.
- Provide traffic control as necessary.
- Maintain communications with the security group at all time.
- Have an emergency escape route.

Incident Containment: When and Why Containment is Appropriate

When to Perform: When it's "Safe" (sometimes "No Safe Containment").
Why is Containment Preferred: Limits the spread of contaminants, reduces life and health risks, protects the environment and property, reduces cleanup costs, limits liability.

Typical methods of defensive containment:

- Dike (i.e., make a small curb with dirt around drain)
- Dam (i.e., build overflow dam for a product that sinks in water)
- Divert (i.e., build small dike to change direction of flow)
- Disperse (i.e., apply fog spray in chlorine cloud)
- Dilute (i.e., apply water to water soluble material)
- Cover (i.e., lay salvage cover over powder spill)
- Foam (i.e., apply AFFF to large gasoline spill)

Control: Offensive "Control" Strategy

Hazard Control is usually defined as all safe acts to stop or stabilize the HazMat release. The Incident Commander must clearly know the difference between "Containment" and "Control". Controlling an incident requires a high level of PPE because it has the potential for moderate or high intimate contact with the material. The goal of controlling is to stop the release of hazardous material, reduce life and health risks, protect the environment and property, start cleanup and limit liability.

Typical methods of offensive control:

- Plug and patch (i.e., fixing a faulty valve or hole in a drum)
- Absorb/Adsorb (i.e., applying pads to an oil spill)
- Transfer (i.e., removing product to a waste vacuum truck)
- Containerize (i.e., putting leaking drums into overpack drums)
- Stop (i.e., simply repositioning a drum or shutting off a valve)

Offensive Control: General Tips and Techniques

Strategies and methods for containment and control should be based on solid Hazard Identification Assessment and other valid selection criteria. The strategy should always include donning proper protective equipment. It is also important that the Incident Commander attempts to utilize the safest and simplest method to get the job done, in line with resource and safety capabilities. Theoretically, contain/control as close to the source as safe and practical.

Incident Commander's Role in Containment and Control

The Incident Commander must first determine if a Non-Intervention, defensive or offensive strategy is appropriate for a particular HazMat release. Next, all control strategies must be safely managed and supported to employ that strategy. Always ensure that the response is in line with responder levels, resources/PPE and capabilities.

Anticipate management challenges:

- Planning problems
- Logistical problems
- Equipment problems

- Operational and Safety problems

Adjust the management of the incident as needed and help stabilize the release. Remember that all hazardous substance incidents eventually stabilize and control actions should direct the stabilization.

Eight (8) Basic Considerations for Selecting Containment & Control Methods

- Physical nature of material
- Physical & chemical properties
- Total amount & rate of release
- Topography
- Weather
- Time available
- Resources & equipment available
- Risk vs. Gain assessment

Practical Containment Tools/Equipment

- Shovels,
- Dump trucks
- Dirt
- Sand bags
- Plastic bags
- Plastic sheet
- Heavy earth moving equipment
- Foam
- Salvage covers
- Absorbents
- Hose
- Redwood plugs

Note: The presence of flammables will require use of non-sparking or intrinsically safe equipment.

Containment of Hazardous Materials

Preventing environmental damage comes second only to saving lives. Methods to restrict or prevent the spread of a hazardous material are outlined below:

Method	Description
Dams	**Simple Dam** - Sandbags, fire hoses, hay bales, lumber, trash bags, plastic sheeting, etc. **Underflow Dam** - Used for releases involving materials that float on water (e.g. gasoline). **Overflow Dam** - Used for releases involving materials that sink in water (e.g. PCB's) **Pros:** Can construct with any material on hand. A holding action, even if not perfect, can buy time. Can completely contain spill. **Cons:** May require constant monitoring and reinforcement. Spilled material may permeate dam. Spilled material may react with organic material in dam.
Dikes	A bank constructed to control or confine a liquid. Can use an absorbent or non-absorbent material (i.e., dirt, plastic sheeting, sand bags, sorbent boom, etc.). **Pros:** Easy to construct. Can use materials on hand. **Cons:** Usually holds small amounts of material. Hard to do when it's raining.
Absorption	To take in and make part of, or to take up and hold. Can use natural materials (i.e., dirt, sand, sawdust, diatomaceous earth, vermiculite, etc.), or man-made materials. Some sorbents are made to float on water and absorb petroleum products. **Caution:** Some sorbents (either natural or man-made) may react with certain hazardous substances.
Covering	Something that is placed over or about another thing, an overlay. Cover the spilled material with plastic sheeting, tarpaulin, foam, water, etc., to prevent powders from becoming airborne or to slow down evaporation of liquids.
Containerizing	To pack in containers. Place leaking drums into overpack drums. Put plastic bucket under leaking pipe, or valve. Usually done by technicians or specialists.
Plugging and Patching	A piece used to fill a hole/Material used to cover a hole. Use available material or prepared tools to stop leaks from containers or pipes. Note: Closing existing valves is a method of plugging and patching. Many piping systems and cargo containers may have such systems - look for them before trying something complex.

Containment Process Priorities

The Incident Commanders goal is to ensure responder safety through proper protective clothing, initiation of control zones and proper containment, control, and isolation strategies. The following list of items will help the Incident Commander determine priorities and course of action:

Non-Intervention	Isolation and deny entry only
Containment	Prevent the spilled material from spreading further
Control	Stop the leak at, or near, the source
Recover	Clean up the spilled material
Process	Think Safety! *Select safest and least environmentally damaging option*

Class Exercise - Selecting a Response Strategy

Indicate which strategy corresponds to the following methods:

1. Non-Intervention (no fight)
2. Defensive (containment)
3. Offensive (control)

Be prepared to defend your rationale!

What Strategies are these methods?

Method	**Strategy**
Isolate	Deny entry from safe distance
Plug & Patch	A piece used to fill a hole/Material used to cover a hole
Retain	Let release collect in low area
Dike	A bank constructed to control or confine a liquid
Absorb/Adsorb	To take in and make part of or take up and hold
Dam	A barrier built across a watercourse for impounding liquids
Divert	To turn aside, to turn from one course to another
Disperse	To break up or spread widely with water or air
Dilute	To diminish strength by admixture
Containerize	To pack in containers (e.g. overpack drum)
Cover	Something placed over or about another thing, an overlay
Transfer	To move to a different place or situation
Foam	A stabilized froth produced chemically or mechanically

In-Class Scenario for Discussion:

What Shall We Do?
Given a spill scenario by the instructor, break into groups and answer the following questions:

- Based on the scenario what strategy would you select? (circle one) Non-Intervention, Defensive Offensive (No Fight), (Containment), (Control)
- What probable method would you employ for that strategy?
- Write a Strategic Objective for the strategy you selected.
- What management problems do you anticipate in carrying out this Strategic Objective?
- A fire has broken out and engulfed the spill area. What adjustments will you make to your strategy?

Be prepared to report your findings to the instructor and provide the rationale for your decision. Three Strategies to Deal With a Release.

1. **No Action vs. Containment vs. Control**
    - No action/Non intervention/No fight: No action other than to safely isolate & deny entry.;
    - Containment (Defensive Action): Slows and restricts HazMat spread.
    - Control (Offensive Action): Stops HazMat release.
2. **Containment is the primary defensive strategy, BUT control vs. contain may be the priority strategy in some cases.**
3. **Remember, it may be appropriate for "No Action" (unsafe, no life risk, lack of resources and minimal potential exposure = No Fight!).**

Session 8. Exercises and Critiques For Responders

Exercises and Critiques are excellent tools for the Incident Commander to use in order to prepare the shipyard for hazardous substance emergencies. Both exercises and critiques are valuable for the learning process. There are 4 basic types of exercises that the Incident Commander should understand and know how use in a progressive program designed specifically for the shipyard responders. Similarly, the Incident Commander must continually exercise and critique him/her-self on managing a HazMat event. This may be performed internally or externally. The Shipyard Incident Commander is essential in promoting and delivering good exercises and critiques for the people they will manage.

Value and Purpose of Exercises and Critiques

Exercises are a tremendous training tool to improve performance of emergency responders. Exercises solidify the learning process and add critical thinking to training presentations. Improving individual and group preparedness is a training tool. Similarly, critiques are excellent tools for exercise improvement and identifying lessons learned. Critiques improve performance and overall understanding of the exercise.

"Exercise Defined: An exercise is an activity to promote preparedness, by testing response plans, emergency operations, and standard practices. It utilizes response equipment and trains personnel in proper response techniques.
Note: When developing exercises, determine what is being tested vs. who is being trained and understand the difference between training and testing. Continual exercises are a key to response preparedness and success.

Why Exercise? There are many real benefits from exercise including:

1. Revealing planning weaknesses
2. Identifying resource gaps that may exist in the response plan or resources
3. Clarifying real roles and capabilities of emergency responders and associated equipment
4. Improving coordination, performance, and confidence
5. Building teamwork and communications
6. Fostering cooperation and support
7. Helping responders stay alive during the real thing

Four Federal Types of Exercises

1. Orientation Seminar "Tell Me" exercise/discussion
2. Tabletop Exercise "Talk Me Through It" exercise/discussion
3. Functional Exercise "Partial Practice" exercise
4. Full Scale Exercise "Full Practice" exercise

Exercise Limits

Exercises have limits because responders know that it is only an exercise. This fact does not limit learning or understanding, but it does limit experience since real incidents are the only method to provide Incident Commanders with real experience. The learning can be limited if the Incident Commander does not use the proper learning tools. The Incident Commander needs to encourage and become involved in a hazardous substance incident and use a progressive exercise program. He/she must also encourage responders to become involved in a incident exercise critique after an exercise/event.

Exercise Progressively: Start with simple scenarios and build-up to complex incident response. Progress through different types of exercises to build an increased response capability. As capabilities increase, exercise complexity increases. The program should lead to continuous improvement. If the Incident Commander wants a good response and learning experience for all responders, he/she must get involved.

Keys to good Exercises:

- Top level support and involvement.
- Good design team and leadership
- Thorough preparation and attention to detail with respect to exercise design
- Positive learning scope and clear learning objectives
- Realistic and challenging shipyard scenarios
- Clear introduction and instructions and flexible assignments to enable decision making
- Constructive follow-up discussions and critique

There is a Real Need For Follow-up Discussions After Exercises

The follow-up discussions and analysis is often overlooked, but is the only real way to improve performance and enhance learning. When properly designed, exercises will offer challenges that require decision making. At this point, the “right” answer is not as important as the process of decision making. When performing a post exercise discussion it is a good idea to:

1. Start with positive "No fault" critique
2. Recommend "Strengths" and "Improvements"
3. Identify what went well, what needs improvement
4. Follow-up on-site plans by validating what worked by correcting those areas needing improvement.

Exercise Development

It is important to develop effective training exercises in combination with documents to guide responders with the proper response sequence and subject matters. It is also important to use standard procedures and forms that will be used during actual events. Two methods of systematic response to emergency incidents are the 12 Essential Operation priorities (SIN-CIA-PCP-DDD) and the 5 A’s. The following acronym represents 12 essential operations/priorities in a HazMat response. These should be used to develop response strategies and tactics:

S Safety
I Isolation (and deny entry)
N Notifications

C Command (management)
I Identification and Hazard Assessment
A Action Planning

P Protective Equipment
C Containment and Control
P Protective Actions

D Decontamination and Cleanup
D Disposal
D Documentation

The following five A's Checklist is an excellent tool for responders to used when evaluating a hazardous substance incident scenario:

Five Strategic Periods Acronym (5 A's) Checklist	
Arrive	Establish command Establish an Incident Command Post Don't forget "SIN" (Safety, Isolation, Notification)
Assess	Initial organization Initial actions Identification and Hazard Assessment
Action Plan	Ensure appropriate planning process Establish strategic objectives for the "Incident Action Plan". Approve "Site Safety Plan"
Assign	Give formal assignments via briefing Provide support to carry out assignments Establish communication links
Adjust	Monitor activities via good communications Do strategic decision making/problem solving Consider next operational period and/or clean-up

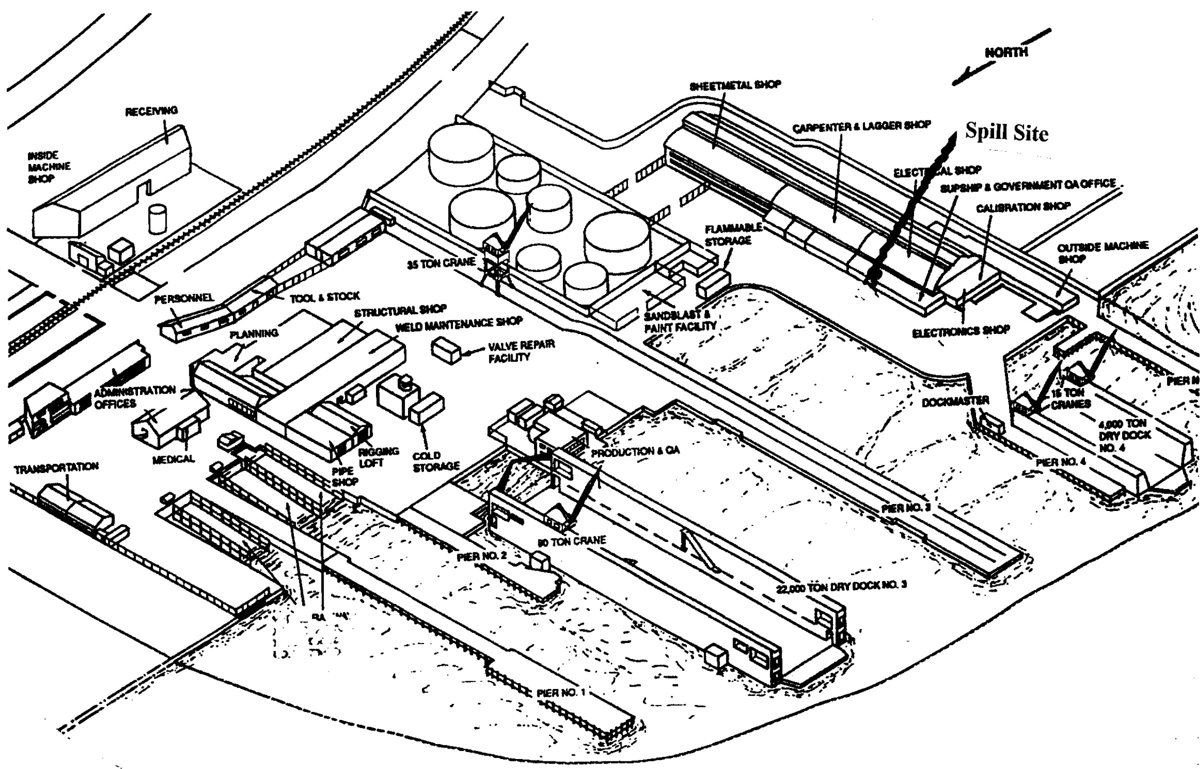
Other documents that should be incorporated into the training exercises are as follows:

- Hazard Identification and Assessment Form
- Site Safety Plans or Incident Response Plans
- Hazardous Substance Data Sheets
- Incident Hazard Analysis Sheet
- Hazardous Incident Containment and Control Operations
- Event Specific Safety Plans

Session 9 Exercise 1A Management Problems

Scenario Description

At 2030 hours, a new employee of a shipyard electrical and plating shop was assigned to inventory stock of supplies and hazardous materials. The warehouse had a NFPA symbol with the blue diamond numbered 4, the red diamond numbered 3, the yellow diamond numbered 2 and the bottom white diamond with no marking. Upon entering the door, he saw a his supervisor collapsed inside the warehouse next to a leaking material that was a colorless liquid with a pungent odor. His eyes immediately started to get irritated and he felt weak. He then returned to the main office, picked up a MSDS and called the On-Site Fire/Safety and Rescue. Two shipyard firemen arrived, started to treat the supervisor and within minutes they also collapsed. The employee then called 911. Media picked-up the incident over the scanner and arrived before the Fire Department and Police Unit. The employee thinks that the material is Acrylonitrile and that there was at least 1 drum leaking in the building. The shipyard is located in a large industrial park, full of similar buildings and some residential dwelling, within 3 square blocks down wind. Wind is from the North to the South at 7.5 mph.



Scenario Plot Plan

Please answer the following questions:

Given this scenario, take 15-20 minutes to discuss it with your teams. Then pick a spokesperson to give a 2-3 minute report of your findings regarding the following <u>MANAGEMENT PROBLEM QUESTIONS:</u>

1. What are the recognition clues that this is a HazMat event? What are the safety guides/rules to follow?

2. As the Incident Commander, where and how would you isolate this event and what calls may be required for notifications?

3. What agencies should respond to this event? What are their roles, and how can the Incident Commander ensure coordination?

4. Who would be the Incident Commander at this incident, and what Incident Command positions would be activated to manage the event?

5. How would you deal with the media, and what emergency message would you issue to the public via the press?

6. What kinds of plans are required for this event? List all the tactical/operational priorities to manage the event.

7. What is the chemical involved, what are the hazards, and what are the key physical and chemical properties?

8. Identify the 5 "A's" for the Incident Commander at this event, and note the key considerations?

Incident Commander Exercise 1A Discussion Points

The following information provides possible discussion points for the above questions:

1. **What are the recognition clues that this is a HazMat event, and what are the safety guides/rules to follow?** [Shipyard Plating and Electrical Shop, 55 Gallon Containers, NFPA 704, Men Down, Senses, etc. - Safe Approach Distances Upwind, Upgrade & Upstream, Positive Safety Attitude etc.].

2. **As the Incident Commander, where and how would you isolate this event and what calls may be required for notifications?** [500' Upwind & 1000' Downwind Of Warehouse, 150' Around Warehouse Door As Exclusion Zone (See NAERG96 131) - Local/ Dispatch & Administration Agency: 911- Office Of Emergency Services Warning Center (800) 852-7550, NRC: (800) 424-8802].

3. **What agencies should respond to this event, what are their roles & how would the Incident Commander ensure coordination?** [Fire Department, Police Department, Emergency Medical Services, Hazardous Materials Response Team, Response Contractors, Environmental Protection Agency, Health Services Department, Fish and Game, etc. - Joint Command Post, Incident Command Coordination and Control, etc.].

4. **Who would be the Incident Commander at this incident and what Incident Command System positions would be activated to manage the event?** [Fire Department, Police Department and Health in Unified Command - Incident Commander, Safety Officer, Action Plans, Operations, Security, Evacuation Team, Medical and HazMat Groups, and others as needed].

5. **How would you deal with the media, and what emergency message would you issue to the public via the press?** [Activate a media officer and evacuation/shelter-in-place officer and if needed, an evacuation team. Evaluate content in teams evacuation message (Stress: Stay out of area)].

6. **What kinds of plans are required for this event and list all the tactical/operational priorities to manage the event?** [Pre-event & Event-Specific Planning, Incident Action Plan, Site Safety Plan, Business Plan Evaluate And Understand].

7. **What is the chemical involved, what are the hazards, and what are the key physical and chemical properties?** [Acrylonitrile - Highly Flammable, Health & Reactive - Flash Point 30^{o}F, Boiling Point 171^{o}F,- LEL 3%, UEL 17%, Vapor Density 1.9, Specific Gravity .8, Soluble/Floats].

8. **Identify the 5 "A's" for the Incident Commander at this event, and note the key considerations?** [**1) Arrive**: Assume Command & Organize, **2) Assess**: Gut Identification and Hazard Assessment. **3) Action Plan**: Approve Comprehensive Missions, **4) Assign**: Missions to Incident Command Positions, **5) Adjust**: Monitor & Alter].

Session 10. Incident Exercise 1B - Commander Management Process

Exercise 1A Scenario Description:
At 2030 hours, a new employee of a shipyard electrical and plating shop was assigned to inventory stock of supplies and hazardous materials. The warehouse had a NFPA symbol with the blue diamond numbered 4, the red diamond numbered 3, the yellow diamond numbered 2 and the bottom white diamond with no marking. Upon entering the door, he saw a his supervisor collapsed inside the warehouse next to a leaking material that was a colorless liquid with a pungent odor. His eyes immediately started to get irritated and he felt weak. He then returned to the main office, picked up a MSDS and called the On-Site Fire/Safety and Rescue. Two shipyard firemen arrived, started to treat the supervisor and within minutes they also collapsed. The employee then called 911. Media picked-up the incident over the scanner and arrived before the Fire Department and Police Unit. The employee thinks that the material is Acrylonitrile and that there was at least 1 drum leaking in the building. The shipyard is located in a large industrial park, full of similar buildings and some residential dwelling, within 3 square blocks down wind. Wind is from the North to the South at 7.5 mph.

Exercise 1B New Information:
The City dispatched 2 Fire, 2 Police and 1 Emergency Medical Service units to the scene, plus the on-duty Public Safety Supervisor to assume the role of Incident Commander. The employee now confirms, from information in the Business Plan and the inventory report, there are a total of ten 55 gallon drums of Acrylonitrile stored in the warehouse. The employee can also confirm that at least two drums are leaking out of control near the front door. There is a storm drain located approximately 50' outside the door, leading to the nearby water, at a minimal to moderate grade. The wind is from the North to the South and has increased to 10 mph, although conditions are expected to change due to clouds on the horizon in the West. You are the first Shipyard Incident Commander at the scene.

Given this scenario, take 15-20 minutes to address the questions on the following sheet and/or complete an Incident Objective form. Be prepared to defend your actions. Consider the following <u>MANAGEMENT PROCESS:</u>

1. **ARRIVE:** Safety, Isolation, Notification, and Command

2. **ASSESS:** Identification and Hazard Assessment (Plus Initial Organization & Actions)

3. **ACTION PLAN:** Action Planning (including Planning for Incident Action Plan and Site Safety Plan) Do Not Forget Proper Protective Equipment.

4. **ASSIGN:**
   - Containment and Control
   - Protective Actions
   - Decontamination and Cleanup
   - Disposal
   - Documentation

5. **ADJUST:**
   - Reorganization and adjust previous Tactical Operations
   - Through Monitoring and Communications
   - Make adjustments as needed

Incident Commander Exercise 1B

HAZMAT MANAGEMENT PROCESS QUESTIONS

S. How can you ensure overall safety, and what are your primary and secondary *safety* concerns?

I. Where would you establish the *Isolation* Perimeter? Where are the Entry Points, and what incident positions are needed?

N. What resource *Notifications* are necessary?

C. Who should be in *Command* of this incident, and where should the Joint Command Post be located?

I. What is the NAERG96 Guide Number and what are the *Identification and Hazard Assessment* factors?

A. What *"Action"* strategy should be taken until the HazMat Team arrives, and should a Site Safety Plan be developed?

P. What level of *Protective Clothing* is required in the Exclusion Zone?

C. What would be the best *Containment & Control* method?

P. What would be the best *Protective Action* to select?

D. Should *Decontamination and Cleanup* be performed by the HazMat Technicians?

D. By whom and how will the hazardous material/waste be *Disposed*?

D. What *Documentation* is most important for the Incident Commander?

Please use this sheet to make notes and write your answers on the following Incident Objectives Form.

Incident Objectives Form

Incident Objectives:	
Date Prepared: ________ **Time Prepared: ________**	**Incident Name:**
Operational Period (Time/Date):	
General Control Objectives For the Incident (Include Alternatives):	
Safety:	
Isolation:	
Notification:	
Command:	
Identification:	
Action Plan:	
Proper PPE:	
Contain & Control:	
Protective Actions:	
Decontamination:	
Disposal:	
Documentation:	
General Safety Message:	
Attachments:	
Prepared By:	**Approved By:**

Example HazMat Incident Action Plan

Incident Objectives:	
Date Prepared: *7/1/97* **Time Prepared:** *2100 hours*	**Incident Name:** *Shipyard Plate Shop*
Operational Period (Time/Date): *First Operational (2100 -2400)*	
General Control Objectives For the Incident (Include Alternatives): *As Follows:*	
Safety: *Ensure Overall Safety at Incident. Assigned to Safety Officer.*	
Isolation: *Establish and Maintain a Perimeter around security fences. Establish visible contamination reduction, support, and exclusion zones. Assigned to the HazMat Technicians.*	
Notification: *Make all Mandatory Notifications and notify the media regarding the status of the incident. Assigned to the Environmental/Information Officer.*	
Command: *Maintain Command at a Joint Command Post. Transfer Command to the most senior official and control the main gates. Assigned to the Incident Commander.*	
Identification: *Continue a Complete Identification and Hazard Assessment. Assigned to HazMat Technicians, Specialists and the Incident Commander.*	
Action Plan: *Develop a written Incident Action Plan and a written Site Safety Plan. Assigned to the HazMat Technicians, Specialists, and the Incident Commander.*	
Proper PPE: *Ensure proper PPE at ALL Times. Note: Level A PPE ensemble in the Exclusion Zone and SCBA within 150 feet. Ensure that Decontamination personnel is using Level B.*	
Contain & Control: *Contain through covering the storm drain and diverting and diking with compatible materials. Assigned to the HazMat Technicians.*	
Protective Actions: *Evacuate the industrial area within 1 mile, as a precaution due to the quantity of storage.* ***Note:*** *The rescue is to be determined by the HazMat Technicians first entry.*	
Decontamination: *Conduct proper decontamination procedures for all entry responders and victims.*	
Disposal: *Responsible party to dispose of waste properly after the event.*	
Documentation: *Document all occurrences, action items, costs, exposures, etc. Assigned to an Incident Commander Assistant and other HazMat Technicians.*	
General Safety Message: *Maintain proper approach directions and distances, stay 150 ft. from the spill without proper PPE. Monitor with CGI, control ignition sources, no confined space entry without proper PPE and procedures, material may be carcinogen, MAINTAIN SAFETY!*	
Attachments: *Site Safety Plan*	
Prepared By:	**Approved By:**

Incident Commander Exercise 1B (Discussion and Answers to Questions)

S. **How can you ensure overall safety? What are your primary and secondary Safety concerns?** *(Via Safety Officer - Primary: Health and Flammability, Secondary: Control entry & ignition sources, safe approach, distance, etc.)*

I. **Where would you establish the Isolation Perimeter? Where are the Entry Points, and what incident positions are needed?** *(Use security fence as natural barriers around site - main gate entry points - Security Group)*

N. **What resource Notifications are necessary?** *(911 Emergency, HazMat Response, Emergency Medical, Fire Department, Police Department - Other reporting may be necessary including EPCRA, NRC, RWQCB)*

C. **Who should be in Command for this incident and where should the Joint Command Post be located?** *(First is the Shipyard Incident Commander and then the Public Safety Supervisor - Joint Command Post should be located inside Main Gate, near the guard shack)*

I. **What is the NAERG96 Guide Number and what are the Identification and Hazard Assessment factors?** *(Per Guide 131- Chemical Name: ACRYLONITRILE - Hazards: Health, Extreme Fire, (P) Potential Polymerization, Volatile + Carcinogen, FP 30 F, LEL 3%, UEL 17%, VD 1.9, SG .8, Soluble, TL V- TWA 2 ppm Skin (Skin absorber), etc.)*

A. **What "Action" strategy should be taken until HazMat Team arrives, and should a Site Safety Plan be developed?** *(Defensive in the beginning by the shipyard, may go Offensive when the Local HazMat Team arrives - Site Safety Plan needed by the HazMat Team)*

P. **What level of Protective Clothing is required in the Exclusion Zone?** *(Level A should be required for entry within 50 of building (and inside building) - Install an initial cover over the storm drain in Level B Turnouts with SCBA + CGIs for monitoring building explosive potential)*

C. **What would be the best Containment & Control method?** *(Containment: Isolate, Cover Storm Drain, Dike Or Divert, Alcohol Foam, & Possible Dilute - Control: Plug & Patch, Overpack, Transfer, Absorb, Ventilate, Gel Agents, etc.)*

P. **What would be the best Protective Action to select?** *(Evacuate within 5 blocks due to Toxic and Flammable Nature, Small Population-threatened, Adequate Law Enforcement, and Time of day, No rescue without Level A due to Risk vs. Gain assessment, concentrate on close downwind and shipyard employee first, also ships force stationed in the shipyard)*

D. **Should Decontamination and Cleanup be performed by the HazMat Technicians?** *(Decontamination procedures should be set up with help from trained shipyard Technicians -* Although, *Cleanup should be performed by the Responsible Party (RP) (i.e. the shipyard) or a designated and qualified clean-up contractor.*

D. **By whom and how will the hazardous material/waste be Disposed?** *(Responsible Party (shipyard) or Contractor - absorbed, gel agents, contaminated dirt removed etc.)*

D. **What Documentation is most important for the Incident Commander?** *(Incident Action Plan, Site Safety Plan, Unit Logs, exposure records, etc.)*

Session 11. Emergency Medical System and Decontamination Considerations

The Incident Commander is in charge of the entire emergency response, which includes all emergency medical situations, as well as the decontamination of responders, victims, and equipment. Decontamination procedures have, as a goal, to limit the spread of contamination, while the Emergency Medical System is designed to provide victims with medical needs. This training module centers around the following Incident Commander questions regarding decontamination and Emergency Medical Services:

- What does the Incident Commander need to know about decontamination, rescue operations and Emergency Medical Services and how they interface?
- What key planning and logistics are needed to implement proper decontamination?
- How does "Managing a HazMat Event & Medical Response" affect the Incident Commander?
- Must the Incident Commander understand the Emergency Medical System?
- Where do Emergency Medical System personnel and Hospital Staff fit into the shipyard Incident Command System?
- What problems are anticipated with a Mass Casualty and/or HazMat incident?
- How do "Decontamination and Cleanup" considerations affect the Incident Commander?
- What are the practical Decontamination procedures to use?
- Who is in charge of the Decontamination Team?
- Should Decontamination be setup before responders enter the hazard area?

The Emergency Medical System

The Incident Commander must understand the local Emergency Medical System and their capabilities in the immediate area of the shipyard. This knowledge should be complete to understand how a patient/victim will move through the medical system. A thorough understanding of the Emergency Medical System will help the Incident Commander determine how to interface correctly during actual HazMat events. The Incident Command System must identify who actually performs the rescue, decontamination and medical aid. It must be understood that rescue, decontamination and medical aid for even small numbers of victims, require a large amount of personnel, supplies and protective equipment.

Coordination Problems in Medical HazMat Events:

There may be many coordination problems with the medical system at HazMat events, including the following:

1. Failure to train and exercise together on HazMat simulations
2. Lack of hazard recognition by medical and other responders
3. Poor communication between medical and other responders
4. Lack of integrated HazMat and Medical plans

Note: These same coordination problems can occur with any discipline at a multi-agency incident response.

The Incident Commander must know the roles of field medical vs. hospital staff and be able to answer the following questions:

1. How do they fit into incident command system medical group?
2. What about hospital emergency room decontamination procedures?

3. How do Emergency Medical System and Incident Commander interface?
4. How does the Mass Casualty Plan work with the shipyard HazMat Plan?

All HazMat Events are Potential Medical Emergencies

It is extremely important that the Incident Commander understands that HazMat incidents can cause many casualties, especially through inhalation exposure. As the number of victims increase, the management problems can become overwhelming. This requires the Incident Commander to keep control of a wide range of responsibilities. The Incident Commander is to ensure the availability of Emergency Medical System with substantial transportation capabilities. It is also important to have a specified triage area that is strategically located to allow for rapid transport of victims.

Allied Medical Health Professionals and the Incident Commander

Allied medical health professionals are frequently associated with local hospitals, on-site medical personnel, and other emergency response organizations. The Incident Commander must work together with all allied medical health professionals. The Incident Commander should be aware that the National Fire Protection Association Standard # 473 (Professional Competencies for HazMat Emergency Medical System Responders) can impact the requirements for emergency medical personnel at a HazMat event.

Seven Tips For a HazMat Emergency Medical System Response

The following acronym (MEDICAL) is used to provide the Incident Commander with these important considerations when responding to an emergency involving hazardous substances:

M Must recognize HazMat event, think safety and then address medical issues.
E Early communication between Incident Commander, HazMat group and medical group is essential.
D Decontamination before transporting to hospital.
I Integrate HazMat and medical plans.
C Continually train and exercise medical group and HazMat group together.
A Always understand HazMat and Emergency Medical System needs.
L Learn to work within the Incident Command System as a team.

Emergency Response Decontamination

During a hazardous substance emergency, harmful materials can be transferred into clean areas, which can unnecessarily expose unprotected personnel to contamination. To prevent such occurrences, methods to reduce contamination and decontamination procedures must be developed, and established, before anyone enters a site. For example, proper decontamination while removing contaminated clothing will minimize the potential of others becoming contaminated. The decontamination procedures must continue and be modified as necessary throughout emergency response operations.

The extent which decontamination must be performed will depend on a number of factors, the most important being the type of contaminants involved. The more harmful the contaminant the more extensive and thorough decontamination must be. Less harmful contaminants may require less decontamination. The correct method of doffing personnel protective equipment, and the use of site work zones, minimizes cross-contamination from protective clothing to wearer, equipment to personnel, and one area to another. Personnel responding to hazardous substance incidents may become contaminated in a number of ways including:

- Coming into contact with vapors, gases, mists, or particulates in the air
- Being splashed by materials while sampling or opening containers
- Walking through puddles of liquids or on contaminated soil
- Using contaminated instruments or equipment

Prompt, safe and effective decontamination procedures are essential to protect victims and hazardous materials response personnel. Decontamination is important for the following reasons:

- It prevents workers from becoming contaminated when leaving contaminated areas and removing (doffing) their PPE.
- It protects workers' families from contamination when workers return home.
- It protects non-contaminated areas from becoming contaminated.
- It protects the surrounding environment and community.

Exposure vs. Contamination

The Incident Commander must know that decontamination procedures are guides to what should be performed and that they are not absolute standards. The decontamination procedures will vary for each event, but should follow a logical order. Proper decontamination procedures should not be overlooked and emergency decontamination procedures should be in-place to ensure that victims are transported to medical treatment as soon as possible.

The negative consequences of limited or improper decontamination that may happen to the victim, rescue assistance, medical personnel and/or hospital staff include acute and/or chronic health effects and even death.

The Why, When, Who, And How of Decontamination	
Why Decontamination is necessary:	To prevent escalation of HazMat problem.
When To Do Decontamination:	Anytime contamination is suspected (when decontamination is not done or done poorly causing the incident to spread/escalate).
Who/What Should Be Decontaminated:	Victims, responders, spill areas, and equipment.
Who usually Performs Decontamination:	Technician Level properly trained and equipped and specialists through the development and implementation of a Decontamination Team.
How to Decontamination:	No absolute methods - Only general guides

Types of Decontamination

There are three basic types of decontamination as described below:

1. **Primary Decontamination** refers to the decontamination procedures that are provided to personnel working in the Exclusion Zone or the Contamination Reduction Zone. This generally includes responders working in Level A or Level B protective clothing. Primary decontamination may also be referred to as "Level A" or "Level B" Decontamination, or Full Decontamination.

2. **Secondary Decontamination** is sometimes called Medical Decontamination. It refers to decontamination that is provided to employees that may have been exposed to hazardous chemicals, but are not displaying any related symptoms of exposure. Secondary Decontamination may also be used following Emergency Decontamination for victims displaying related symptoms. During Secondary Decontamination, there is time to contain runoff water and

provide for modesty. This level of decontamination might involve the use of tents, trailers, tarps, containment basins and/or showers. Rinse water will be contained in underground tanks if fixed shower systems are in place. Secondary Decontamination is generally too time consuming for victims with immediate life-threatening injuries/exposures.

3. **Emergency Decontamination** refers to decontamination that is urgent and field or site expedient. Most often it is performed on employees, civilians or response personnel who have had a direct exposure to hazardous solids, liquids, mist, smoke and certain gases, and who are displaying related symptoms. Emergency Decontamination is a two-stage decontamination process. The first stage consists of clothing removal and a two-to-five minute water rinse. The second stage is a soap-and-water scrub and rinse. Exposures to the eyes might involve flushing for 15 minutes or longer. The environment and personal modesty are not of primary importance when there are potentially life-threatening injuries/exposures. Emergency Decontamination may be followed by Secondary Decontamination if deemed necessary by local protocol, the Incident Commander and/or the Poison Control Center.

Decontamination Case History Example	
Problem:	A large chemical manufacturer experienced a chemical reaction to one of its large blending tanks. The primary chemical involved was Hexanediacrylate.
Action Taken:	Upon arrival, a captain and two firefighters donned full protective clothing and SCBAs before entering the structure to size-up conditions.
Error Made:	Upon exiting the structure, the Captain walked over to the Command Post, removed his face-piece and proceeded to report on conditions. The two firefighters, however, kept their SCBA face-pieces in place until after they had taken a booster-hose line and decontaminated themselves by thoroughly flushing each other off with water.
Results:	By not decontaminating himself before removing his SCBA face-piece, the Captain breathed lethal chemical vapors evolving from his turnouts. Due to this error, he has been medically retired and is expected to die due to the chemical vapors permanently altering his central nervous system.

Decontamination Incident Commander Management Issues

Incident Commander must address the following Management issues:

- Operational adequacy of the decontamination plan and the availability of decontamination resources and training. Potential problems and limits in the shipyard environment.
- Required level of PPE must be determined for the decontamination team. Theoretically, the same level of entry protective clothing (or one level down) is required for decontamination team personnel.
- Technical help for decontamination is very important for an effective decontamination response. The Incident Commander must know where is decontamination team is, what decontamination resources are available, and how to access decontamination information 24 hours a day.
- Decontamination of contaminated victims prior to transporting is mandatory. Ensure that rescuers understand that there are special precautions for HazMat medical emergency decontamination.

Bottom-line: The Incident Commander has the responsibility to institute appropriate decontamination procedures as a part of the emergency response operations.

Decontamination Team Personnel, Roles and Responsibilities

The shipyard should have a decontamination "Standard Operating Procedure" and all of the Technician Level Responders must be trained to perform Decontamination Team roles. It is important to identify individuals to the “Decontamination Team Leader." Other decontamination team key roles and tasks must be assigned to appropriately trained responders. Regular practice of decontamination set-up and operating procedures through drills and exercises is absolutely necessary.

Sample Decontamination Equipment List

The following list reflects typical minimums and is *not* all inclusive.

Item	Quantity	Additional information
Containment pools	4	
Garden hoses	5	50'X 3/4"
Manifold	1	1 inlet X 4 outlets
Tarpaulins/plastic sheets	3	16'X 20'
Traffic cones	25	2’ high
Traffic delineators	*5*	3’ high
Barrier tape "Hazardous Materials"	1	Roll
Redwood plugs	25	1-1/2" X 6"
"Rinse wands"	4	With shut-off
Plastic bags	25	36" X 60"
Plastic trash cans	4	30 gallon
Step ladders or stools	6	18" high
Sprayers	2	Hudson type
Plastic pails	4	5 gallon
Soft bristled brush	5	Long handled
Hard bristled brush	5	Long handled
Sponges	5	
Wash mittens	5	
Liquid detergent	1	Gallon

Other Decontamination Area and Equipment Considerations

- Select an area that can accommodate the decontamination set-up (i.e., flat).
- Ensure the decontamination team has an adequate water supply.
- Make provisions for the disposal of decontamination water and runoff.

Session 12. Protective Action Options: (Evacuation Vs. Shelter-In-Place)

There are essentially two ways to protect the public from the effects of toxic emissions or vapor discharges into the atmosphere. One of these methods is evacuation and involves removing the public and shipyard employees from areas at risk to areas of safety/refuge. Evacuation is the most common and frequently effective protective action used by emergency response organizations. The other protective action involves keeping people inside structures and having them close doors, windows, ventilation systems, etc., to make the structure as air tight as possible, this prevents intrusion of contaminants. Employees and/or the public are instructed to remain inside their homes or places of business until the danger passes. In other words, it involves telling people to "Shelter-in-Place" or use "In-Place Protection". Evacuation is the preferred protective action, however, it may be logistically and operationally difficult to execute for large evacuation areas. Sometimes shelter-in-place is the only practical protective action, especially in congested urban areas or highly dense office areas. The decision regarding protective action is one of the most important decisions to be made by the Incident Commander.

Evacuation and Shelter-In-Place Considerations

The following six items must be analyzed before the Incident Commander can make the decision to evacuate an area, or to use shelter-in-place response actions:

- Materials involved
- Population threatened
- Capability of emergency responders
- Time factors involved
- Current & predicted weather
- Ability to communicate with public

The following table illustrates the concepts and questions about a hazardous substance incident that need to be considered:

Consideration	Questions To Consider
Materials Involved	Is it solid, liquid, or gas? If it is a solid, is it powdered or crushed so it can give off dust particles? If It is a liquid, will it give off flammable, explosive and/or toxic vapors? Will the material rise or sink in air/water? Is it flammable? Are the characteristics unknown? Is the material toxic or irritating to human tissues? What is the route of entry? If the material burns, will it give off toxic byproducts? Is there a potential for a large spill? Is the material presently contained? Is the container exposed to flame impingement? Is the container damaged?
Population Threatened	The number and status of the people potentially affected will have a major impact on a decision involving protective actions. Is the spill near a populated area? Is it near sensitive populations or special facilities? Are there areas where the vapors will collect? Are there things such as waterways or storm drains that may trap the material or transport it to another location? How far away are the people from the incident? Are they downstream, downwind and

	downgrade? If not, and if the wind shifts, is this location at risk? What type of area is at risk? Residential, commercial or industrial? Is it a densely populated area? What language do the residents speak? Will the number of people in the area vary with the time of day? What structural protection is available? Can the potentially affected population help themselves?
Capability of Emergency Responders	The capabilities and resources of available response organizations will determine the Incident Commander's ability to implement and control any protective actions. Can responders deploy their resources quickly? What specialized resources do they have available immediately? What specialized resources do they have available under mutual aid? Can responders control or contain the spill? Can responders transport special populations? Can they control expected traffic? Can responders set up and manage shelters? Can responders be notified and deployed? Can responders communicate with each other?
Time Factors Involved	The time of day the incident occurs and how long it may last will largely determine what type of protective action to select. What day of the week is it? How long will the release last? How long will it take vapors/gases to reach populations at risk? How long will it take to deploy responders? How long will it take to set up environmental monitoring?
Current & Predicted Weather	The existing and predicted weather will affect both the dispersion of the material and the ability of people to evacuate. How will the weather affect the movement of the vapors/gases? Which way is the wind blowing? How strong? Is there any rain, snow, hail, etc. (or any chance of any)? What are the normal weather patterns for the area? What is the expected weather for the next operational period? Will bad weather block escape routes? Will the weather slow down the evacuation? Will high air temperatures/humidity reduce the ability of people to remain in shelters?
Ability to Communicate With Public	The ability to communicate with the public will impact the Incident Commander's ability to notify people of protective action plans and the ability to communicate with responders will impact the Incident Commander's ability to manage the operations. Can the public be quickly warned? Can protective action instructions be clearly communicated (in their own language)?

When is Evacuation Necessary?

Evacuation is clearly safer with respect to the specific hazards posed by a toxic gas or vapor release. However, it has certain limitations that may pose new problems. A major evacuation takes time and may not be feasible once large amounts of toxic gases or vapors have entered the atmosphere. If people in the path of a toxic cloud or plume leave their homes this may cause greater harm than good. Large-scale evacuations in response to toxic gas or vapor hazards are best considered when:

- There is a strong potential for a toxic discharge, the discharge has not yet taken place, and there appears to be time available to safely relocate people,
- The discharge has taken place but people are sufficiently downwind to permit time for evacuation,

- People not yet in the direct path of a cloud or plume are threatened by a future shift in the wind direction,
- The safety hazards of evacuation are outweighed by benefits of the action, and/or,
- In-Place protection might not fully protect threatened populations from serious consequences of a release.

Evacuation and Movement

Purpose: The purpose of an evacuation is to remove the public and employees from the area threatened by a hazardous material incident. Depending on the nature of the incident and the means for propagating the hazardous condition (i.e., a vapor cloud transported by the wind, gravity flow of a toxic liquid down a gutter, underground flow through utility conduits, or by current flow of a material spilled in a waterway), the size of the danger zone, and the time available for protective measures, may vary considerably.

Responsibility: It is often the responsibility of a local government to assess the situation, make the decision to evacuate, and formulate an evacuation plan for areas outside of the shipyard. Urgency, population density, possible evacuation routes and terrain must be considered when selecting the means to effect the warning and evacuation. Evacuation may be voluntary or mandatory, depending on the nature of the hazard and the conditions surrounding the incident. The evacuation warning should include such information as: type of evacuation (mandatory vs. voluntary); best available routes out of the area; location of reception and care facilities, (if established); anticipated duration of the emergency; and time remaining before the situation becomes critical. The Incident Commander should advise the Office of Emergency Services (OES) Regional Office when conditions require a significant evacuation.

Law Duties (Police Department): If an evacuation is necessary, it will be the responsibility of the law enforcement agencies to conduct an orderly evacuation (outside of the control Zones) and to ensure property evacuated is secure.

Performance: According to Federal Emergency Management Association (FEMA) research, the best evacuation performance is 10,000 people per hour for communities that have accomplished significant planning (such as with nuclear power plants).

Sequence of Steps For Evacuation

Evacuations can range from a small building to a large building or an entire shipyard. Evacuations can also include the public immediately adjacent to the shipyard. The following is a sequence of operations that may assist in determining if an evacuation is necessary, and the steps to make the evacuation safe and orderly for employees, citizens, and public safety personnel.

<u>Step One</u> - Analyze the information

- Collect all the information about the threat and the threatened area
- Validate the information by reviewing all sources of conflicting information, and substantiate as much information as possible with a second source
- Determine the degree of the hazard by examining the potential of the hazardous material by type, amount, and spread (looking at the immediate, midterm and long-range problems)

<u>Step Two</u> - Evacuation preparation

- Determine the area that will require evacuation, using considerations of terrain, flow rate, wind and cleanup time.

- Estimate the number of people in the evacuation area. If it is a residential area, the City Clerk or Planning Department can give the Incident Commander a close estimate. If it is a business area, the businesses know the number of their employees. Remember the variance due to time of day.
- Estimate the number of people needing assistance with transportation, such as people without autos or with handicaps that may prevent them from using private transportation.
- Coordinate with the Evacuation Group Supervisor to identify major evacuation routes and establish traffic control points taking into consideration the condition of the roads and their load carrying capacity.
- Coordinate with the Public Works Department to establish preliminary evacuation assembly points. Then ask the Parks and Recreation Department to locate shelters for evacuees and pets, and notify the Red Cross to open designated reception centers.
- Notify the Emergency Broadcast System to broadcast the evacuation warning (coordinate this notification with the jurisdiction Public Information Officer), and dispatch units to warn the threatened area.

Step Three - Evacuation

- The Evacuation Group Supervisor should dispatch units to traffic and access control points. Two trucks should be placed to assist the on-scene manager with monitoring the status of the warning and evacuation processes. Law enforcement should be prepared to provide crown control at assembly points.
- The Public Works or Parks and Recreation Coordinator should dispatch buses to the designated assembly points. They should also dispatch specialized transportation to homes and facilities housing the elderly, disabled, and other requiring special assistance.
- Know the Incident Commander agency's policy on "resisters" (i.e. those that won't evacuate).

Step Four - Security of the evacuated area

This is the most difficult due to harmful vapors that may enter into the evacuated area.

- Establish security patrol and access control procedures. Coordinate with the Public Works Department to obtain and position barricades and signs.
- During notification and evacuations in a residential area, law enforcement personnel will need to know the location of people with physical impairments so they may be contacted personally.
- Expect to find people who have refused to leave the area. The Incident Commander must anticipate and plan for this.

Need For Pre-Event and Event Specific Planning for Evacuations

Many groups are frequently needed for evacuation planning before and during the event. For example, industry, law enforcement, fire, schools, volunteers, community groups, and the media. Evacuation plans may be developed before the HazMat event occurs but evacuation plans will require event specific planning to verify or modify the pre-event evacuation plan. This event specific plan will be utilized to document evacuation methodologies and effectiveness.

Example agencies involved in planning and implementing evacuations:

1. Primarily Law Enforcement (actually conduct evacuation)
2. Fire Service (give technical advice on the size of evacuation area)
3. Parks Departments (for possible shelter locations)
4. Schools and Universities (for possible shelter locations)
5. Volunteers (American Red Cross for shelter management)

6. Media (to assist with issuing evacuation message)
7. Industry (individual companies, associations, etc.)
8. Others - Mental Health Professionals; local OES; etc.

Ten elements of a good evacuation plan include:

1. Coordination with all agencies
2. Clear delineation of the area to be evacuated
3. Clear evacuation routes to be used
4. Traffic control measures specified and set-up
5. Shelters designated for care of evacuees
6. Methods to involve people without transportation
7. Special procedures specified for unique institutions
8. Procedures specified for security of evacuated area
9. Procedures set for lifting evacuation order
10. Clear and concise evacuation message

Don't forget: A Good "Public Education Program" informing citizens what they should do to help themselves if an evacuation is needed can pay big dividends during an actual evacuation operation.

Sample Evacuation Checklist (A.P.O.E.)

Analysis

- Determine the area(s) that will require evacuation
- Estimate the number of people in the evacuation area
- Estimate the number of people needing transportation assistance

Preparation

- Coordinate with the Law Enforcement Coordinator to identify major evacuation routes and establish traffic control points
- Establish evacuation assembly points
- Notify radio and TV stations to broadcast warning
- Notify Red Cross to open designated reception centers
- Coordinate with Public Works to obtain barricades and signs

Operational

- Dispatch units to warn threatened area
- Dispatch transportation to special facilities and to the disabled, elderly and other requiring assistance
- Dispatch buses to designated assembly points
- Dispatch units to traffic and access control points
- Provide crowd control at assembly points
- Place tow trucks on standby to assist disabled vehicles on evacuation routes. Establish security patrols and access control procedures

Evacuation

- Monitor status of warning and evacuation progress
- Monitor traffic flow on evacuation routes
- Maintain security in evacuated area

Evacuation Management

The three management phases when implementing evacuations are:

- The Preparation Phase (i.e., preparing evacuation order & logistics).
- The Operational Phase (i.e., actually executing evacuation order).

- The Evaluation Phase (i.e., security to evacuated area & lifting order).

The Incident Commander can expect common management problems in each phase (i.e., planning, organizing, coordinating, resources, resisters, reentry, etc.)

Shelter-in-Place Issues

The Shelter-in-Place protective action involves keeping people inside structures and having them close doors, windows, ventilation systems, etc., to make the structure as air tight as possible and prevent intrusion of contaminants. Employees and/or the public are instructed to remain inside their homes or places of business until the danger passes. Evacuation is the preferred protective action although, it may be logistically and operationally difficult to execute for large evacuation areas. Sometimes shelter-in-place is the only practical protective action, especially in congested urban areas or highly dense office areas. For example, evacuation of hospitals, high rise buildings and institutions is not very practical and needs lots of time, resources and joint planning.

Do not forget other key Shelter in Place considerations, including:

1. Need for Pre-event and Event Specific Planning
2. Key elements of a Shelter in Place Plan through a pre-planned message or announcement
3. Management issues include the ability of a facility to provide Shelter-in Place
4. Need for public education on understanding the Shelter-in-Place concept
5. Special logistical needs (i.e., facility communication equipment)

Recommended Shelter-In-Place Instructions

Sheltering-in-place can provide some degree of protection from toxic gases and vapors in the atmosphere. The limitations of the practice center on minimizing outdoor air infiltration and/or ventilation rates into buildings/shelters. This section draws upon substantial data to present a list of suggested instructions to be given to populations asked to shelter-in-place. The suggestions are as follows:

- Close all doors to the outside and close and lock all windows (windows sometimes seal better when locked). Close curtains/drapes.
- Building superintendents should set all ventilation systems to 100 percent recirculation so that no outside air is drawn into the structure. If not possible, shut off ventilation systems.
- Turn off all heating systems.
- Turn off all air-conditioners and switch inlets to the "closed" position. Seal any gaps around window type air-conditioners with tape and plastic sheeting, wax paper, wet towels or aluminum wrap.
- Turn off all exhaust fans in kitchens, bathrooms, etc.
- Close all fireplace dampers.
- Close as many internal doors as possible.
- Use tape and plastic food wrapping, wax paper, or aluminum wrap to cover and seal bathroom exhaust fan grills, range vents, dryer vents, and other openings to the outside to the extent possible (including any obvious gaps around external windows and doors).
- If the gas or vapor is soluble or even partially soluble in water, hold a wet cloth or handkerchief over your nose and mouth if the gases start to bother you. For a higher degree of protection, go into the bathroom, close the door, and turn on the shower in a strong spray to "wash" the air. Seal any openings to the outside of the bathroom as best as you can. Do not worry about running out of air to breathe. That is highly unlikely in normal homes and buildings.

- If an explosion is possible outdoors - close drapes, curtains, and shades over windows. Stay away from external windows to prevent potential injury from flying glass.
- Minimize the use of elevators. These tend to "pump" outdoor air in and out of a building as they travel up and down.
- Tune into the Emergency Alert System on your ratio or television for further information and guidance.

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